

S. HRG. 108-36

**SEVERE ACUTE RESPIRATORY SYNDROME THREAT
(SARS)**

HEARING
BEFORE THE
**COMMITTEE ON HEALTH, EDUCATION,
LABOR, AND PENSIONS**
UNITED STATES SENATE
ONE HUNDRED EIGHTH CONGRESS

FIRST SESSION

ON

EXAMINING THE SEVERE ACUTE RESPIRATORY SYNDROME THREAT,
FOCUSING ON THE ISSUES OF VACCINE DEVELOPMENT, DRUG
SCREENING, AND CLINICAL RESEARCH

APRIL 7, 2003

Printed for the use of the Committee on Health, Education, Labor, and Pensions



U.S. GOVERNMENT PRINTING OFFICE

86-493 PDF

WASHINGTON : 2003

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512-1800; DC area (202) 512-1800
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C O N T E N T S

STATEMENTS

MONDAY, APRIL 7, 2003

	Page
Gregg, Hon. Judd, a U.S. Senator from the State of New Hampshire	1
Kennedy, Hon. Edward M., a U.S. Senator from the State of Massachusetts ...	2
Gerberding, Julie L., M.D., M.P.H., Director, Centers for Disease Control and Prevention; Anthony S. Fauci, M.D., Director, National Institute of Allergy and Infectious Diseases, National Institutes of Health; and David L. Heymann, M.D., Executive Director, Communicable Diseases, World Health Organization	5

ADDITIONAL MATERIAL

Statements, articles, publications, letters, etc.:	
Julie L. Gerberding, M.D.	36
Anthony S. Fauci, M.D.	39
David L. Heymann, M.D.	41

SEVERE ACUTE RESPIRATORY SYNDROME THREAT (SARS)

MONDAY, APRIL 7, 2003

U.S. SENATE,
COMMITTEE ON HEALTH, EDUCATION, LABOR, AND PENSIONS,
Washington, DC.

The committee met, pursuant to notice, at 12:01 p.m., in room SD-430, Dirksen Senate Office Building, Senator Gregg [chairman of the committee] presiding.

Present: Senators Gregg, Sessions, Kennedy, and Dodd.

OPENING STATEMENT OF SENATOR GREGG

The CHAIRMAN. We will begin this hearing. I want to thank Senator Kennedy for persisting in making this hearing possible on the fast track, but I especially want to thank our three witnesses today, who are leading the effort to try to contain and address the threat of SARS, the sickness which has obviously gained international attention and represents a significant health concern for all of us.

The SARS disease has spread across the world, although it is centered obviously in China, but I noted in the most recent statistical analysis that after China, if you consider Hong Kong to be part of China, which it is, Canada becomes the Nation with the second largest known cases of SARS.

It obviously raises huge issues for us as a nation and for the world as a community, issues of how we contain it, issues of how we address it and hopefully find a cure for it, issues of how we identify it to begin with, of course.

The health community has worked extremely aggressively on the international and national level, and I certainly want to congratulate the World Health Organization for their superb effort at trying to bring coherence to how we address this health threat, and we will have with us today, addressing us from Geneva, Dr. Heymann, who is the head of the World Health Organization in this area.

We also have joining us today the head of CDC, Dr. Julie Gerberding, who has done an exceptional job in a lot of different areas, but is obviously leading the fight in this area; along with Dr. Fauci, who is the leader at NIH in the area of communicable diseases, who has been before the committee on numerous occasions and is also coordinating and leading this aggressive effort to try to get our hands around and arms around this significant health threat, to not only our country but to the world.

These two agencies, NIH and CDC, are the premiere agencies not only in our country but in the world in the area of combating communicable diseases, and therefore, their leadership is important, not only to us here in the United States, but to the world community as a whole, as we address the SARS threat.

So it is a pleasure to have them here today to testify before us. They are the ones we want to hear from. We are limiting opening statements to myself and Senator Kennedy, and I yield to Senator Kennedy at this time.

OPENING STATEMENT OF SENATOR KENNEDY

Senator KENNEDY. Thank you very much, Senator Gregg, for calling this hearing, which is enormously important, and incredibly significant to our fellow citizens here in this country and people around the world, and I join you in welcoming Dr. Gerberding and Dr. Fauci who are two very special leaders, not only in understanding this challenge, but in so many other health-related areas.

It is less than a month since the first report surfaced of this dangerous new disease and it has already spread around the globe with thousands of cases and dozens of deaths. We live in a time when deadly disease can leap oceans and travel the globe in a matter of hours, as fast as an airline passenger can fly. It spreads easily from person to person and there is no vaccine or miracle cure. The evidence indicates that it is caused by a virus. Treatments based on how we treat flu-like disease are all we can provide so far. The best weapons in combating this deadly disease are the skill of our health care workers and the ingenuity of our scientists.

I had the opportunity to hear from some of the Nation's best doctors and scientists at a forum on SARS on Friday in Boston. We drew on experts from clinical medicine, public health and basic science to hear the best insights and recommendations of how to respond to this extraordinary new health challenge. Even without a single death so far in the United States, the impact of SARS has been significant. I heard on Friday that restaurant bookings at Boston's Chinatown have dropped by over 60 percent because of fears of an outbreak there. The State health department is receiving over 200 calls a day about the disease. A recent town meeting held by the Boston Department of Public Health drew over 100 people last week when they were expecting 15 or 25, all anxious to receive the latest information.

Congress has provided a down payment on the resources that will fight this epidemic. Last week the Senate accepted an amendment that Senator Clinton, Senator Murkowski and I offered that will add \$16 million to the CDC, the Centers for Disease Control budget to fight SARS, and I understand that the CDC has assigned over 300 personnel to this outbreak, so more resources will clearly be needed in the near future. Health departments across the country are already reeling under the impact of budget cuts and the burden of implementing the smallpox vaccine plan, and this new epidemic will strain their capacities yet further.

SARS is also a wake-up call for another reason. There is no indication it began as a terrorist attack, but what if it had? A virus can be just as destructive as a bomb or a missile. Homeland security means protecting our country against health threats as vigor-

ously as we protect against military threats. Yet today we are already stretched to the limit in protecting the country against bioterrorism. Obviously, we must provide the resources needed to meet both the manmade threat of terrorism and the natural threat of SARS.

Senator Frist and I held hearings in the past on possible threats from bioterrorism. The bioterrorism provisions in the bill enacted after 9/11 were a key turning point in preparing a response. We have been worried about the other germ threats as well such as West Nile virus. We are concerned about the widespread routine use of antibiotics in agriculture for animal feed, and the danger that germs will mutate into forms that are resistant to all forms of antibiotics. Clearly, we need to strengthen our defenses against these perils.

Health departments and hospitals across the Nation are taking needed steps to improve preparedness against these modern disease threats. At a time like this it makes no sense for either Congress or the states to be cutting reimbursements to public health agencies and hospitals struggling to face these challenges.

Today we will hear about SARS from three of our best experts. Dr. Gerberding has led the CDC through some of its greatest challenges in its history. She has helped protect the Nation against the deliberate use of infectious disease as a weapon, and now the talents of CDC's extraordinary doctors are being mobilized against SARS. One of the points made at the forum on Friday was the extraordinary respect by public health professionals for the job that CDC has done in responding so far.

We are also pleased that Dr. Fauci is here. He and the NIH have given extraordinary service to the Nation in their work on AIDS and many other infectious diseases, and I commend him for his leadership. We are also honored to have David Heymann from the World Health Organization joining us by video conference. He is at the forefront of the emergency international efforts to combat SARS.

I look forward very much to the testimony of these impressive witnesses at this extremely important hearing.

I thank you, Mr. Chairman.

[The prepared statement of Senator Kennedy follows:]

PREPARED STATEMENT OF SENATOR KENNEDY

I commend the Chairman for calling today's hearing on SARS. It's less than a month since the first reports surfaced of this dangerous new disease, and it's already spread around the globe, with thousands of cases and dozens of deaths. We live in a time when deadly disease can leap oceans and travel the globe in a matter of hours—as fast as an airline passenger can fly. It spreads easily from person to person, and there is no vaccine or miracle cure. The evidence indicates that it is caused by a virus, and treatments based on how we treat flu-like diseases are all we can provide so far. The best weapons in combating this deadly disease are the skill of our health care workers and the ingenuity of our scientists.

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science to hear the best insights and recommendations on how to respond to this extraordinary new health challenge.

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I look forward very much to the testimony of these impressive witnesses at this important hearing.

The CHAIRMAN. Thank you, Senator Kennedy.

The procedure we are going to follow is to hear from Dr. Gerberding, then Dr. Fauci, and then Dr. Heymann in Geneva, who we very much appreciate joining us by satellite.

If we could start with you, Dr. Gerberding?

STATEMENTS OF JULIE L. GERBERDING, M.D., M.P.H., DIRECTOR, CENTERS FOR DISEASE CONTROL AND PREVENTION; ANTHONY S. FAUCI, M.D., DIRECTOR, NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS DISEASES, NATIONAL INSTITUTES OF HEALTH; AND DAVID L. HEYMANN, M.D., EXECUTIVE DIRECTOR, COMMUNICABLE DISEASES, WORLD HEALTH ORGANIZATION

Dr. GERBERDING. Senator Gregg, Senator Kennedy, we really appreciate this opportunity to appear here today. I think it is so important to get this kind of information out to the public and to Congress as it evolves, so I really am very, very grateful for this change.

As you know, in November mysterious reports of a severe respiratory illness emerged from Guangdong Province in China, and by February there were well-documented reports of some cases of a new pneumonia in Hong Kong. By March, WHO recognized that this disease was spreading rapidly in Hong Kong and in Hanoi, and issued a global health alert on March 12th.

On March 14th, CDC activated its emergency response center to deal with what we recognize would likely be a complicated multi-jurisdictional international outbreak investigation, and since that time we have been mobilizing our full emergency response capacity, our communications capacity, as well as our laboratory science capacity to support the public health response.

What you can see on this graphic is that this has very quickly become an international epidemic, starting here in Asia, but then with foci of cases across the entire globe. We, today, are aware of 2,301 international cases, plus an additional 148 cases here in the United States involving 30 states. So we are continuing to aggressively evaluate suspected cases in the United States. The case definition for SARS is nonspecific, basically a traveler to an affected area or someone who has had contact with a SARS patient who develops a fever and respiratory symptoms. Many of these people have SARS, some have other common respiratory illnesses. One of our biggest challenges right now while we are trying to contain spread through public health and infection control measures is to get a diagnostic test as quickly as we can.

Let me show you just in a little more detail the situation of the United States because I think it helps understand how this disease is being transmitted. On the next graphic I have what we call the epi curve or the epidemiologic curve, and you can see that over time, beginning in early February and then progressing to where

we are at the end of March, there are increasing numbers of cases being detected in the United States, but all of the cases in blue are cases in people who have traveled to Asia, Hong Kong, Hanoi, Singapore, areas where this disease is spreading. The green bars right here represent contacts of these case patients in the United States. There are only five individuals right now who have SARS as a consequence of household exposure in this country. Then here there are two health care workers who acquired SARS or at least acquired a disease consistent with SARS from a case patient, and recently over the weekend, we have a third health care worker who has been added to the suspected case list.

This is a pattern that is very different from what we are seeing in other parts of the world, probably because we were able to get aware of this and implement the appropriate hospital isolation precautions very quickly to protect health care workers, and then the home infection control precautions to protect household contacts. But we are also concerned that there are some people, the so-called hyper transmitters or super spreaders, as we have heard it in the press, some individuals may be especially infectious or especially contagious. So there is always the chance that we will be seeing a further spread of the infection here in this country just as it has been observed in Canada and elsewhere in the world.

On my final graphic I have a picture of the virus that we believe is the leading hypothesis as the cause of this illness. This is a coronavirus. It is called corona because in this section it looks like a crown, with the spokes of the crown coming out from the circular virus. Coronaviruses cause diseases in a whole array of animal and bird species, including cats, dogs, pigs, cattle and so on and so forth. They are an important veterinary pathogen, and there are many vaccine products that have been created to try to protect animals from coronavirus with various degrees of success, sometimes not all that successfully. We know a great deal about coronaviruses as a family.

The laboratories at CDC in Hong Kong first isolated coronavirus from early patients, and since that time at least eight other laboratories have found evidence of coronavirus infection in the patients. What is important to us is, first of all, this is a new coronavirus. It is not like any others that we have become aware of, and we expect that our laboratory and other labs this week will likely have the entire genome of this virus sequenced. It is one of the largest viral genomes that exists, and it is a single strand of RNA which means it is very unfaithful as it reproduces itself, so it can evolve over time, and that is why there are so many different species of this virus in animals and so forth.

We do have tests now that can detect evidence of coronavirus infection. We actually have three tests that we are using to look at the case patients. Two of them are based on antibodies that develop in patients over time, and one of them is a PCR test that can find pieces of the virus genome in specimens from the case patients. So as we evolve the reagents and get these tests out into the health community, we will better understand the spread, but will also be able to help in individual cases identify patients.

The last thing I wanted to mention is the issue of treatment. This is a new virus and we do not have things on the shelf that

we know are effective against coronavirus. Many clinicians around the world have been using ribavirin which is a drug for other kinds of virus infection. We just do not have the right kind of clinical information to make any judgment about whether it is effective or not, although I think increasingly we are a little pessimistic that it is actually going to be a useful drug. We are working with the U.S. Army Medical Institute of Infectious Disease Research to screen drug compounds, and if anything tests positive, we will be able to go from there. I think Dr. Fauci is going to give a little more information on drug screening and what we might see in the future for vaccine.

To summarize all of this, I would say that what we have here is an epidemic of new virus or some virus that is causing problems in virtually every corner of the globe. We are controlling it primarily by identifying exposed end-case patients and implementing public health measures to prevent spread. We do not know where this is going to go. If we are lucky, it will have a seasonal pattern and it will wane over the summer months or maybe what we are seeing in the early stages as this large increase will level off. But we are taking it very seriously. We have to be prepared for this to continue to spread, and we are doing everything we can across the public health system, the scientific system, as well as the research system, to be out in front of it.

Thank you.

The CHAIRMAN. Thank you, doctor.

[The prepared statement of Dr. Gerberding may be found in additional material.]

The CHAIRMAN. Dr. Fauci?

Dr. FAUCI. Thank you very much, Chairman Gregg, Senator Kennedy, Senator Dodd. As Dr. Gerberding mentioned, I truly appreciate the opportunity to appear before this Committee that has been in the past so helpful to us in our own endeavors over the past several years in emerging and reemerging diseases, and most recently in the arena of biodefense against weapons of bioterrorism.

I want to start off by echoing the point that Senators Gregg and Kennedy made regarding the job that the Centers for Disease Control and Prevention and the World Health Organization have done on this. As a research scientist involved in infectious diseases, the degree of competence and collaboration that the Centers for Disease Control and Prevention have manifested in this is really quite extraordinary, and I wanted to take this opportunity to publicly thank Dr. Gerberding and her colleagues at the CDC for the most extraordinary job that they have done.

This is a poster that I have shown in this room on more than one occasion, but I have added something to it, and it is in some of the hearings that we have had in the past on the whole concept of emerging and reemerging infectious diseases which are a threat to our species essentially from the beginning of mankind and indefinitely. When we talk about a reemerging disease we talk about something that was a disease in a place or in a form that we had not seen before. A good example of one that we have recently encountered is West Nile virus, which is not a new virus at all, but it is now in a different place, namely in the United States, when

in fact it had not been before 1999. An emerging infection is one that is new to our species. A good example of that is HIV/AIDS.

If you look at this rather complicated slide of a number of emerging and reemerging diseases, some of them every once in a while evolve into a major public health threat, and others, relatively speaking, are little blips on the radar screen in that they stay confined to the time and the place when they initially emerge. With SARS we know for sure that we are not dealing with just a blip on the radar screen, but as Dr. Gerberding says, we are not really sure where it is going to go because we are truly in the middle of the evolution of an epidemic. We just do not know whether it is going to peak and then go down, or whether it will go down and then come back up at a different season. For that reason we have to take this very, very seriously.

Dr. GERBERDING mentioned that the prevailing evidence—and it gets stronger and stronger each day—is that we are dealing with a coronavirus, and she made some important points about it so I will not spend much time on it except to say that since the coronaviruses as a group are a known group of virus, there has been research going on for years in a number of laboratories, also several laboratories in the extramural and intramural program that have been supported by the National Institutes of Health. As Dr. Gerberding mentioned, it is both a veterinary and a human infection. There are no adequate therapies and no adequate vaccines. But we do have people who have been working on them for several years.

What I would like to do is just spend a minute or so, very briefly touching some of the areas of research. Dr. Gerberding mentioned the surveillance and the epidemiology. We have NIH-funded investigators who are actually very closely aligned in Hong Kong with looking at the evolution fundamentally of new influenza viruses from animals, from pigs and fowl, and those individuals are now currently collaborating with the Hong Kong group, and have actually isolated a coronavirus in confirmation of the CDC's activity.

When you talk about basic research one of the things that is interesting about this is that coronavirus is generally a fastidious virus that is difficult to grow in culture. We have found, with the help of the CDC who have given us the material that they have, that this virus grows quite well on certain cell lines such as a viro cell line, which is a monkey-derived line. The reason that is in some respect—in the sober situation that we have now—good news, is because it would have been very difficult if we could not grow the microbe. Assuming this is the microbe, which we feel strongly that it is, this is a situation where we now have the microbe in hand and we can actually start producing it for the purpose of testing it against antivirals, and as I will get to in a second, take a look at the situation vis-a-vis vaccines.

The pathogenesis means how does this microbe cause its pathological effect, the genesis of the pathology? That is what we are going to be studying very intensively now that we have the virus, because we are not sure at this point whether it is the virus itself that is causing all the damage in the lungs of the individuals or if it is the virus together with what would be a normal immune response, but in some diseases the immune response itself causes

damage. We have certain infections in which a certain type of an immune response can actually make the pathological effect worse. We see that in some cases of respiratory syncytial virus, in some cases of measles. So it is important for us to nail down the pathogenesis.

The big item is vaccines. Right now again, fortunately, we have the virus growing in culture, so the step-wise approach to developing a vaccine, the easiest thing to do quickly is to take the virus, kill it, and have what is called an inactivated virus. That research is going on as we speak right now at the NIH in Bethesda as well as in other areas of the country and the world.

The first thing you do is you grow it and you determine in fact if you can get an animal model in a mouse or in a monkey. The fact that it grows in monkey cells gives us optimism, though we have not proven it yet, that a primate model might be a good model to test a vaccine. The other thing you do is you take the sera from people who are recovering or who have recovered and find out once you infect an animal if the sera can block the disease in that animal, then that is a pretty good indication that a vaccine might work. These are all the steps that are rapidly going on.

Dr. GERBERDING mentioned the drug screening development program. We are collaborating with the CDC and USAMRIID in that regard. We are looking at panels of drugs that already exist. You might recall that when we developed our first drug against HIV it was in a screening program of a drug that came off the shelf. The very first drug was AZT. You remember very well, Senator Kennedy, we discussed that many, many years ago at this panel, in which we actually had a drug that came off the shelf.

There are other drugs like interferon that we know work against certain viral diseases. We use it in hepatitis C. We are going to be testing it in this particular situation.

Immune-based therapy, namely, when someone recovers can you isolate from their plasma the immunoglobulins that are directed against the virus, and therefore perhaps use that in a way for therapy.

I already mentioned animal models.

Finally, clinical research at the clinical center in Bethesda. We will be setting up protocols in collaboration with the CDC and other of our colleagues, that if we have cases that are actually in the area that we can look at, we would be able to execute some of the protocols, be they immune-based therapy, be they treatment protocols or be they understanding the pathogenesis.

So you see, although this is an extraordinary challenge and we cannot give any guarantee at this time, the mobilization of the research endeavor together with the public health endeavors of the CDC have been extraordinary. So in closing, Dr. Gerberding has shown how the public health system, in a very, very difficult situation, is in fact working. What I have shown you is a very brief example of how the investments that we have made over many years in the arena of emerging and reemerging diseases can and will be rapidly applied to address this situation of SARS as well as the inevitable situations that we will surely face in the future with other naturally occurring or deliberately released pathogens.

Thank you very much; would be happy to answer any questions.

The CHAIRMAN. Thank you, Dr. Fauci.

[The prepared statement of Dr. Fauci may be found in additional material.]

The CHAIRMAN. And now we will turn to Dr. David Heymann, who is in Geneva. He is the Director of Communicable Diseases with the World Health Organization, and I want to again thank the World Health Organization for the extraordinary job they have done in focusing world attention on this and trying to coordinate an international response, and hopefully their technology will also work, and we look forward to hearing your thoughts, doctor.

Dr. HEYMAN. Thank you, Mr. Chairman. It is a privilege to speak with you today and speak with our doctor collaborators from CDC and NIH. As you surely know, WHO depends greatly on the United States and its facilities, and especially on CDC and NIH to support our activities worldwide.

WHO implements the International Health Regulations, which are a set of norms and standards set out for airports, seaports and other ports entering countries, and also refers reporting of infectious diseases. These regulations are adhered to by our 192 member countries.

Over the past 5 years WHO has been revising these regulations to be more in touch with the 21st century, and the outbreak of SARS has given us the unexpected opportunity to try out the operational procedures which we have been developing as we revise the International Health Regulations. And it is under the authority of the International Health Regulations that on February 10th, WHO, through its office in Beijing was working with the Chinese Government to learn more about an epidemic in Guangdong of acute respiratory infection that had begun on the 16th of November.

On the 17th of February WHO then spread its team into Hong Kong as well because at that time there were two persons who had the bird flu or H5N1 virus identified from them. So there was a heightened concern on respiratory diseases in China and Hong Kong at the period, when on the 28th of February in Vietnam there was a case of a very atypical pneumonia which rapidly progressed to respiratory failure, and which by 5 days later had infected 22 health workers in that hospital. At the same time we learned that there were outbreaks of a similar disease going on in Hong Kong. It was not clear yet whether this disease was influenza or whether it was some other disease, but on the 12th of March, because this disease was a very serious disease involving for the most part at that time health workers, we went out with a global alert, as Dr. Gerberding has said, notifying all of our countries in the world that there was a new unrecognized disease in Asia.

After the 12th of March we were working with countries, and on the 14th of March, 2 days later, we had a report from Canada that they had put their health authorities on alert that there was a similar disease occurring in Canada.

On the 15th of March at 2:00 a.m. in the morning we received a phone call from Singapore, indicating that a physician who had been attending a congress in New York was on his way back to Singapore with a similar disease. We had that plane diverted to Frankfurt and the patient was isolated in Frankfurt.

But on the 15th morning here in Geneva we had several concerns. I will just list those concerns for you. First of all, the cause of this respiratory syndrome was at that point unknown. We knew that it was very important to health workers because health workers were the major people at this time who had been infected; about 90 percent of all cases were in health workers. We knew that antibiotics and antiviral drugs that we were using did not seem to be having effect. At the same time the disease was spreading international. It had gone to Canada. It had gone to New York, and it was now in Frankfurt as well. And it was a serious disease which spread very rapidly in some instances to respiratory or breathing failure, requiring respirators. And finally, at that point in time, not knowing what the disease is, we understood that it was best or easiest transmitted from person to person by close contact, and we thought that possibly by raising a global alert, in addition to preventing many health workers from becoming infected, we might be able to contain this disease as it was starting up, so that it would not become still another endemic disease, a disease such as tuberculosis or malaria which affects human populations.

We continued with our global surveillance and response, tracking the disease around the world with our colleagues in many institutions including CDC, and on this 27th of March it came to our attention that there had been passengers on international flights who were sitting adjacent to persons who now we knew had SARS, who had become infected on those planes. So on that date we recommended that countries which had this disease begin screening the passengers leaving to make sure that if there were passengers with this disease, they would not fly at that time, but rather be referred to health workers. Many countries such as Canada and Hong Kong and Singapore, those countries where there was community level transmission and the greatest epidemics, did institute these practices.

On the 7th of April though we looked again through our figures, and we found on that date two different events. We found that passengers continued to travel out of Hong Kong with the disease, and in fact 9 passenger had traveled to areas in Taiwan, in Singapore, and in other countries, with the disease after the 15th of March when we had put out our alert. So passengers were still traveling, and at the same time on that same date we understood that other issues were occurring in Hong Kong, that this disease appeared not to be close contact to person to person only, that it had somehow been able to spread from one person to another through an object of something in the environment in an apartment complex in Hong Kong.

With these two understandings we made a recommendation that passengers postpone voluntarily travel to Hong Kong and also to China because at that point we did not clearly understand what was going on in Guangdong in China.

On the 17th of March we began three collaborating groups, laboratories, epidemiologists, those people who study infectious diseases, and clinicians, to better understand the disease, and Dr. Gerberding has given a good summary of what we understand from those groups.

One issue was a very important issue to us, and that was China. And as you know, China had not been open with the information about the disease, as open as we had hoped, despite our working intensively with them. But gradually over the period from 10th February until the present they have become a full global partner in this outbreak investigation. We now have a team which is in Guangdong Province. We are working in other cities in China to understand the issue.

Now, the issue that we understand in China was that health has been delegated to provincial levels, and the Federal and national government had no authority over those provincial governments as far as infectious diseases were concerned. That has changed 1 week ago when China has instituted a national reporting system for SARS and some other infectious diseases, requiring provinces to report this information to Beijing, and this information is now also being made available to us.

So we see this global response, although it has been long in coming, has included a partner which was reticent at the start. We hope that as we continue this response and afterward as we continue the revision of the International Health Regulations, we will be able to require that all countries work closely when there is a disease of international importance. The response has been remarkable to date. Laboratories have collaborated, sharing information that maybe 5 years ago they would have kept to themselves, so they public first, and we see that the world has responded the way we had hoped it would.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, doctor. I appreciate that excellent overview. I appreciate the excellent overview of all three of our superb witnesses here today.

[The prepared statement of Dr. Heymann may be found in additional material.]

The CHAIRMAN. If I could direct my first question to Dr. Heymann. Can you give us a sense of what you are projecting is the spread of this disease, number one? And number two, do you feel that the countries which have the most severe outbreak of it, specifically China, and you alluded to this, presently are able to control its spread within their borders, and communication outside of their borders?

Dr. HEYMANN. Let me start with Vietnam, which called for help early. Vietnam called for an international team very early. The epidemic was well contained and there will be a few cases, but we believe it is contained in that area.

In Guangdong in China, the epidemic we believe has been going on from the 16th of November and our team has information that it continues in the Guangdong Province, and we also have information that other provinces are affected. China will begin to work with WHO. We do not know the extent to which they will work with us, but on that WHO team are the best experts in the world coming from CDC, coming from Australia, coming from Japan and many other countries. We will be talking with our WHO office in Beijing tomorrow, and hope that we will have from them an idea of how much more reinforcement we can send in, and we believe that we will have the opportunity to help the Chinese contain the

outbreak there. Hong Kong is a concern. We will be reinforcing our team in Hong Kong at their request today also.

So the outbreaks are being contained. We hope that we will be able to work closely with China to continue what has been an ongoing and long-term epidemic in China, and we believe that we will be able to contain at least some of the epidemics.

As far as what will happen internationally, I do not believe anyone can tell you, Mr. Chairman, what will happen. We are all waiting to see. We are all doing our best to make sure that it is contained as it spreads.

The CHAIRMAN. What are you recommending that countries do, relative to movement of citizens across borders, especially relative to nations which have a high degree of infection?

Dr. HEYMANN. The decision of what a country will recommend must be based on many things. No. 1, it is based on a WHO recommendation, and we have recommended now that travelers avoid Hong Kong and Guangdong because of the spread of the disease in those areas. But national governments must also consider insurance, the possibility of med-evacuating their sick citizens and other issues when they make their recommendations. So we expect that countries will make recommendations which are different from ours because of their understanding of what they can do for their citizens in those countries should they become sick. So our recommendations are for two areas, Hong Kong and Singapore—no—and Guangdong. We understand that the U.S. and other countries have recommendations for other countries as well, and they fit in with our guidelines.

The CHAIRMAN. We have seen these surgical masks being worn throughout airports in China. I would like anybody on our panel to describe to us what is the use for these? Do they have a practical, positive medical use or not?

Dr. GERBERDING. Maybe I can put some perspective on the mask issue. The most important use of masks is for health care workers in health care settings, to protect themselves from case patients, and the health care workers are expected to use a very specific kind of mask that has a better filtration than the use you have just held up. It is called an N95 respirator, and it is the kind of mask that we would use for tuberculosis as part of airborne precautions in health care settings.

The surgical masks that you have raised are useful in keeping large droplets from disseminating from the mouth or nose of somebody who is sick. So we recommend that if a SARS patient is in their home, if they can comfortably wear such a mask, it will help prevent spread to their household contacts. If the patient cannot wear the mask, then we are advising the household contacts to wear the mask so that they do not get exposed to these droplets that come out when you cough or sneeze.

Beyond that, we are not recommending masks for anyone at this point in time. We understand that people are nervous and that in parts of the world where this really is spreading in communities, a lot of people are using them as sort of a just-in-case scenario.

The CHAIRMAN. You have identified 148 cases in the United States or potential cases?

Dr. GERBERDING. Potential.

The CHAIRMAN. Potential cases. Canada, as I understand, has the second largest number of cases in the world after China and Hong Kong. How should we in the western hemisphere be dealing with this, and are we dealing with it adequately, or what should average citizens be doing, and is there something else that our health communities should be doing?

Dr. GERBERDING. The most important step is identifying somebody who may have the condition, and so I think we have been making extraordinary efforts to alert passengers arriving on planes from areas where this disease is being transmitted, and overall, we have actually distributed about 300,000 of those. You have a little yellow card in front of you which is an example of a travel alert.

The CHAIRMAN. We will have it in front of us soon.

Dr. GERBERDING. You will have a little yellow card in front of you. We have translated this into several languages and they are being distributed at the ports of entry from flights coming directly from the affected countries in Asia, but also people who are traveling indirectly via other ports of entry. This is an effort to remind people that they have been in an area where SARS is present, and if they develop a fever or respiratory illness within 10 days after their last exposure, they should contact a health authority and let them know that they could be at risk, so that arrangements can be made for them to come in and be in the proper infection control precautions when they are evaluated.

The second most important thing is that when a SARS patient comes into contact with the health care system that they are immediately put in the appropriate protective environment for isolation purposes, so that it does not spread to health care personnel and others.

The CHAIRMAN. My last question before I turn to Senator Kennedy. I wanted to ask Dr. Heymann, is there anything else that the United States, either the Government or our health professionals should be doing to assist the World Health Organization as it pursues this disease?

Dr. HEYMAN. We will be identifying our needs as we go along, and we have a very close relationship with CDC. In fact, at quarter to 6 Geneva time, just before coming into this hearing, we were talking with our colleagues at CDC about certain needs that we need as far as technical support to countries.

We have also been dealing internationally with IATA which is a federation of airlines transit authorities, and they are gearing up to be able to make sure that transmission does not occur on airplanes, and they have assured us that they are taking all measures they can to deal with this disease.

So from the U.S. we do need technical support. We are getting it, and we greatly appreciate that.

The CHAIRMAN. Thank you.

Senator Kennedy?

Senator KENNEDY. Thank you very much, Mr. Chairman.

We are reminded again about what a small world community we are when it comes to health care. The steps that have been taken by the CDC, are enormously important. We see how rapidly this disease can spread in a very short period of time and affect families here in the United States.

Just quickly, Dr. Heymann, which countries are doing the best things? Could you tell us, are all the nations pretty much following your recommendations that you know of?

Dr. HEYMANN. Yes. All countries are following our recommendations, and there has been a great rallying around this outbreak. In the 21st century there is a new way of working. I have to say that we did not anticipate the support that we have had. We only had one ministry of health concern because they were caught off guard. So it is a solid area internationally on this. And all countries, including the U.S. and Canada, are following the recommendations of WHO.

Senator KENNEDY. For most of your life has been studying these kinds of diseases. How does this one rate? How does this figure in the range of different kinds of virulent viruses or pathogens that you have studied? Where would you put it in terms of its danger to mankind?

Dr. HEYMANN. What is concerning about this disease is that it is a disease which has probably emerged from nature into humans, but instead of having a dead end in humans, in other words, infecting humans and not transmitting on, it continues to transmit through chains of transmission to health workers and then to their family and others.

It is not a highly virulent disease. 4 percent is not a very high case fatality rate, but what is high is the fact that it is killing health workers who are the pillar of our society. So it is a very important disease because of that.

If you look at a disease like Ebola that kills between 50 and 80 percent of people, but that disease is so virulent that it does not have a chance to spread. This disease has spread very rapidly around the world and continues to transmit from person to person. So it is a disease which may not be high as far as mortality, but it certainly is high as concerns transmission around the world.

Senator KENNEDY. Dr. Fauci, do you want to add something to that?

Dr. FAUCI. Yes, Senator Kennedy. I agree with Dr. Heymann. We are all concerned, but since it is an evolving epidemic, I think we need to emphasize—because whenever we say “concerned” some people say, well then, gee, we should be panicking, we should be—what should we be doing that we are not doing? I think that the public health measures that are being taken internationally under the leadership of WHO and internationally and domestically under the leadership of the CDC, are right on, and Dr. Gerberding described some of these. So I am concerned for the reasons that Dr. Heymann mentioned, is the transmissibility, the fact that is a new virus.

The point that Dr. Heymann made is an excellent one. When we had the problem with the bird flu a few years ago and then just most recently the small number this year, it was a type of a flu that is involved with chickens and it is called an H5N1. When it jumped from the chicken to the human, it jumped from chicken to human with several cases. We dodged a bullet because it did not then go from human to human to human. The problem with this one is that it very likely jumped from an animal species to a

human, but now it is spreading in humans, and that is the thing that is concerning us all.

Senator KENNEDY. Dr. Gerberding, I think most Americans want to know what can they do to prevent getting SARS. What would you say to people that are watching this and say, what can I do in order to try and avoid it? What advice would you give them?

Dr. GERBERDING. Right now we have indicated that people should avoid nonessential travel to the countries where this is especially problematic and particularly in community situations. So we are recommending that unless you have to go, defer your trip and wait until we have a little bit better handle on containment in these regions.

From the domestic standpoint, we have a very small number of cases of SARS, but if you are a household contact or a health care worker, to be alert and use the recommended precautions. Beyond that I think what people can do right now is be informed. Stay up to date. Understand where the epidemic is. Understand what is going on in the community.

Senator KENNEDY. Talk to their doctors, get more information?

Dr. GERBERDING. Exactly.

Senator KENNEDY. Do you have websites on this?

Dr. GERBERDING. Yes. I think we passed—I do not know if we passed this out—

Senator KENNEDY. To people that are reading about this hearing or watching the hearing, what can they do? Obviously, we would be interested in telling them about the website, and then calling their public health department or their doctors to find out about it?

Dr. GERBERDING. Absolutely. We have put a high emphasis on trying to get all the information out as quickly as we can. As WHO has something, we turn it around and get it back up. Our website is a very good resource. It is www.cdc.gov, and you can find pretty much all of the guidance, all of the information from WHO and anything else that would offer advice. We have information there for clinicians which are clearly very critical in recognizing cases and implementing isolation precautions.

I should also mention that just Friday, with WHO and CDC and clinicians in Asia, we were able to do a satellite video conference to educate clinicians and infection control professionals globally about how to recognize and isolate SARS patients. So we got many thousands of people who were able to get that information on the Web as well as through the satellite.

Senator KENNEDY. As I understand, there are categories of the communication of various diseases called the R 0 value, which you are familiar with. The tops is measles which is 16, and the bottom is smallpox which is 4. Of course we thought we had eradicated the smallpox. And then there is polio which is 5, and we have made progress. And then there is SARS. The best estimate is 6, which looks like it is fairly low in terms of the range, but that could be deceiving, could it not? This could, if people did not have some form of immunity or potentially some other kinds of protections, I imagine this could go very rapidly through the population. Could you comment on this so that people can understand what we are talking about? We do not want to unduly alarm people, but we ought

to have the best in terms of science information. What is your view?

Dr. GERBERDING. The R₀ is a number that tells us how efficiently a disease is being transmitted, and it has to be greater than 1 for an epidemic to propagate. The estimate of 6 is a very preliminary estimate. One of the things that is probably going on with this epidemic is that in some patients have an R₀ that is quite low. They are not transmitting to very many people at all. And then there may be a few patients for whom the R₀ is very large, and so that is kind of confusing the situation in terms of understanding this. We do not want to alarm people unnecessarily, but we do want to express the fact that this is the beginning of a problem. We are learning as we go. It has the potential to spread very quickly, and we have seen that, and it has the potential to spread globally. We have seen that. So we have got to work with our public health agencies and our clinician community to do everything we can to identify and contain cases when they do occur here and to be alert to where the threats are internationally.

Senator KENNEDY. You mentioned it is the beginning of the problem. And I would ask Dr. Heymann too, where are we? Are we in the first inning? Are we in half time? Are we coming into the—

The CHAIRMAN. They do not do innings in Geneva.

Senator KENNEDY. Dr. Heymann is a good American and understands. Can you tell us where we are? Someone said the first lines of an opening scene. Where are we?

Dr. HEYMAN. Let me go back to what Dr. Fauci said earlier. When a virus emerges from nature into humans, there are many things it can do. It can emerge; it cannot spread from human to human. It can emerge and spread from human to human, attenuate or decrease in its power over time, or it can spread from person to person, continue to spread and become an endemic disease in our population.

We are somewhere between the second and the third as far as our understanding of this disease goes because we have only had a limited time to study it.

We are now in the third and fourth generations of people who are infected. We do not know if this virus will continue with its same power to infect others as we go along, or whether it will drop off as time goes on and not be so virulent. We suspect the worst and we have to be ready for the worst, but we are still between that second part when it transfers from person to person, and maybe decreasing in virulence over time; and the third, when it transfers from person to person, remains a very serious disease. I think probably Dr. Gerberding could probably supplement that a bit better.

Senator KENNEDY. Anything you would add?

Dr. GERBERDING. Yes. It is too early to say is the short answer to your question. We agree with the WHO position that we can be hopeful, but we need to be prepared for the worst-case scenario, and actually we are already looking at our influenza pandemic planning process and seeing if we can translate that plan to make sense for SARS, just in case. We want to make sure that if that worse case scenario does happen that we have got the steps in place to deal with it.

Senator KENNEDY. My time is just about up, just the final two questions. One is, why do there appear to be more deaths in other countries than there are for the cases that we have had here so far?

Dr. GERBERDING. The main reason for the low death rate here is probably that we have a much broader case definition in this country. What WHO is reporting under the probable cases are people who have the whole pneumonia. Here we are reporting travelers with fever and respiratory illness, and less than half of them actually have pneumonia, so we are including people who are not as sick, to make sure that we know who they are and that we are doing everything we can to contain the spread.

Senator KENNEDY. I read in your article, you said there is a possibility we might get a seasonal bounce with this. Can you comment about that, whether you think with coming into the warmer weather—I guess when you have an influenza epidemic, the seasons do not make much of a difference—what do you think with this? Do you think there is some possibility that when you get to the warmer weather in the summer it might diminish to some extent?

Dr. GERBERDING. The other human coronaviruses do have a seasonal pattern, and in fact, most respiratory illnesses are seasonal. The problem is that what is the winter months here is the summer months in the southern hemisphere and vice versa. So a seasonal pattern might allow a specific region to get a head start on containment, but that does not mean the global problem will quiet down at any particular point.

Senator KENNEDY. One point. You put out your warnings in English and in Spanish. You might take a look at doing the other languages. We have a very significant Chinese population in Boston. The public health department in Boston is translating it, but it is taking them some time. I do not know if you have all of these capacities. I mention it because there is a range of different languages in this country now, and to the extent that that could be added, give you one more thing to do.

Dr. GERBERDING. I appreciate that. The travel card is in many languages. But we recognized the same issue, and have put together an Asian community team at CDC this past week to try to do a better job with that. So thank you.

Senator KENNEDY. This little card here was enormously important in Massachusetts because we have two known cases, potentially four cases, but two known cases, one an infant. And the doctor in Springfield, Massachusetts, a pediatrician, was able to diagnose it because they had received this kind of a warning. It just goes to show what it means in terms of communication, good communication early on. Thank you.

The CHAIRMAN. We will recognize people by way of their time of arrival. We would like to keep the questions to 7 to 10 minutes if possible.

Senator Dodd?

Senator DODD. Thank you very much, Mr. Chairman. Let me thank our witnesses. And let me thank you, Dr. Heymann. This is a—well, we lost him, huh? That is not Dr. Heymann. [Laughter.] He think he is Dr. Heymann. [Laughter.]

I appreciate it very much, Mr. Chairman. This is tremendous technology, and listening to you, doctor, talk about the ability to communicate globally as a result of Internet services and the like and taking advantage of this technology for us to be able to talk with someone like Dr. Heymann is important. He is back.

There you are, doctor. We lost you for a minute. You are back again. I notice, just to follow Senator Kennedy, just looking at languages, I do not see Spanish on here. Was this a particular reason why—there is Spanish? Mine has just Korean and Vietnamese, Japanese, traditional Chinese, simplified Chinese. Maybe there are other ones.

Dr. GERBERDING. We need to take care of that.

Senator DODD. It would just seem to me that given the tremendous number of people in the population.

Mr. Chairman, I am going to ask unanimous consent that an opening statement be included in the record as well.

The CHAIRMAN. Certainly.

[The prepared statement of Senator Dodd follows:]

PREPARED STATEMENT OF SENATOR DODD

Mr. Chairman, thank you for convening this important hearing on the emergence of Severe Acute Respiratory Syndrome (SARS). With all of our advances in the field of medicine, it is always shocking when an illness suddenly appears that we know almost nothing about. In this country, we have been very fortunate to have conquered so many of the diseases that have threatened us in the past, that we may begin to feel almost invincible. However, the development of an illness such as SARS reminds us that we must remain vigilant to the threat of new and emerging diseases. Especially in a world that is now so interconnected, it is virtually impossible to stop disease at our borders.

It is always the unknown that is most frightening, Mr. Chairman, and unfortunately we know very little about SARS. That is why I believe that today's hearing has the potential to be quite useful as a forum to address some of the questions and conjecture surrounding SARS. As I am sure all of our witnesses here today would agree, we are best prepared to deal effectively with an emerging threat only when we know exactly what it is that we are confronting. Until we know the true nature of Severe Acute Respiratory Syndrome, we will not be able to effectively form an appropriate response. It is my hope that today's hearing will signify a step toward better understanding the threat posed by SARS and how we might effectively respond to its emergence.

More than 100 people have already died as a result of SARS, and thousands more are infected worldwide. International flights have been cancelled, and businesses are recalling their employees from overseas. Photographs in the news media show ordinary Asians walking to work wearing surgical masks a disturbing image in this uncertain time. All the while, there is very little information about the danger that SARS presents to our nation. The American public and I include myself here is full of questions about how SARS might affect us. Is the danger likely to grow? How can I protect myself and my family? How do I recognize the disease? What should I do if I begin to feel sick?

These questions may be an overreaction based on a lack of information, which is exactly why this hearing is necessary. I am hopeful that today's panelists can answer many of these questions. I know that both the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH) are actively pursuing answers, and I thank our witnesses for taking the time to be here today on such short notice.

Mr. Chairman, I would again like to thank you for convening today's timely hearing. As legislators we have the responsibility to help the American public better understand emerging threats and the possible impact of these threats on their health and well being. We also have the responsibility to provide oversight of the development of an effective federal response to the same threats. It is my hope that today's session will allow us to do both. I look forward to hearing from our witnesses this afternoon.

Senator DODD. Obviously the unknown is what we fear. I will ask a question of one of you, but if others want to jump in, please do.

One, Dr. Heymann, I will begin with you. Are there some lessons that we could be taking—now this is early obviously, and it is only a few weeks here, but it seems to me, given the sort of exponential growth that seems to be occurring with this, and given the point that Dr. Fauci made, and I think you, doctor as well, Dr. Gerberding did, about the ability for this to go not only it appeals from animal to human, but then jumping from human to human rather easily, at least it appears that way, that we may be looking at a more serious situation here. But the lessons to be learned regarding how different countries' health organizations coordinate, that is my question for you, Dr. Heymann. We are letting changes be made as a result of what you have determined already on how the WHO operates. For example, is there anything that could have been done to encourage the Chinese to open up sooner, and to what extent have you been able to determine beyond this particular illness that the Chinese now, given the—at least the stories I have read about Guangdong Province being a province where you have large concentrations of population on relatively small farms with large concentrations of diverse animal populations, that this has been an area that in the past has produced unique or almost unique viruses—so to what extent are we now going to get future cooperation from the Chinese as a result of this experience?

Dr. HEYMANN. As you know, WHO has an office in developing countries, and we have an office in China. So what we were able to do was to get in immediately when we found out about the disease in Guangdong, into our office, which we reinforced with two specialists, one from CDC and one from WHO. Those staff remained however in the office, and were only after a week allowed to talk with the authorities at the Beijing or China CDC.

What we do not have is authority to bypass a State's sovereignty, and this would never be accepted by any of our member countries in a regulation such as the International Health Regulation, because we are not an agency which has the authority to bypass national sovereignty.

The only we can do and what we are trying to do with the new International Health Regulations is to create such a pressure on

countries that they feel the obligation to work with us, and this is what has happened now with China we believe. There has been an apology actually from the Ministry of Health that it was so long in coming on board with WHO and its team. The only thing we can do is make this international solidarity so that all countries do work together and feel a pressure from other countries if they do not.

I know the U.S. is very influential in discussing with the Ministry of Health in China the fact that they should allow our team in, and this together with what WHO was doing and others, certainly we had a role to play in the final opening of China. But we cannot force our presence on countries. We have to force our presence only through an international understanding that infectious diseases are security issues to the whole world and that they know no borders. So hopefully by this lesson we have made one step forward in our ability to work with countries.

I would just add also that for Chinese, which you were speaking about earlier, on the WHO website all of our documents are in Chinese. Thank you, Senator.

Senator DODD. Let me just take it one step further and ask our other panelists to comment. What steps, given the incredible importance of coordinating activities now between the multiple of nations obviously that have to help respond to this, what steps do you think we might take? What steps should the United States take? We are a congressional committee here. We are going to want to know what we can do, what role can we play here if any? A very candid answer may be none at this juncture. What you are doing, by just holding a hearing on this matter and bringing some public attention is more than satisfactory at this juncture. And I accept that answer. If there are some other steps you think we can take, I appreciate, Dr. Heymann, your point about utilizing whatever rhetorical kind of encouragement we can to other countries, but I would find it terribly alarming that as a result of this experience we did not find a far more higher degree of willingness to participate and contribute. My mind is already beginning to think of what steps we might take to encourage, be a little bit more emphatic than encouragement, for nations to participate, and I wonder if you have any specific suggestions that we might consider here as a congressional committee?

Dr. HEYMANN. I would certainly welcome your ideas as to how this could proceed, because we only feel that our mandate goes to creating an international environment where all countries feel an obligation to participate in such an event. If there are measures that you could suggest to us that we could try to work out, we would do that, and perhaps CDC and NIH have some ideas of what they would like to see us do in the future. We are restricted by our—

Senator DODD. I understand that.

Dr. HEYMANN. —192 member countries, and the regulations we have.

Senator DODD. Let me ask you, Dr. Fauci, Dr. Gerberding, do you have any suggestions you would make to us here, such as, for instance, putting out a health warning to nations who do not share

this information? I mean just as a generic warning, to people who travel, for instance?

Dr. FAUCI. I think what has been done thus far is on target for the stage that we are in right now. I think you made the point earlier that since this is a moving target, we need to continue communications, communications among the health agencies, and a very close communication between the Congress and national and international agencies. That is the reason why we welcome this hearing, to make this a good start, and maybe the first in several looks at where we are going.

You made the point regarding that yellow card. I actually as a health person believe, as you made the example, Senator Kennedy, that we are in much better shape now because we actually jumped on that and created a vehicle for people to be able to understand what they need to do if they get symptoms when they come from these countries.

I think the recently signed quarantine order that adds SARS to the diseases that are quarantinable was another step in the right direction, so I think we need to just follow this very carefully and make the appropriate moves as things evolve.

Senator DODD. This morning the New York Times ran a lengthy piece on this issue, and I read a number of articles over the weekend. How do you feel that the news media generally is covering this story? Putting aside the websites. I realize there have been some websites that have been rather alarmist and so forth, but as a mainstream media, television, print, journalism, how well is the story accurately being covered?

Dr. GERBERDING. This morning I looked at the CDC clips on SARS, and it is a stack of newspaper reprints about this big. That is more coverage than we had for anthrax. So I read through the major articles. I did not have time to read through all of them. And it is very impressive, the quality and the caliber of the reporting that we are seeing. I think people recognize this as an emerging health threat. They are playing accurately, not overstating the issues, not understating the issues. I think recently the emphasis on the business consequences have helped people prepare and recognize that there will be other collateral damage from this epidemic, but we have worked very hard to try to educate the media and to make ourselves available to them in any way that we can to get this information out, and we are very impressed with what they are doing.

Senator DODD. Last, let me raise an issue. I have often been told—I believe this is correct—the anecdotal line anyway that the word for “crisis” and “opportunity” in Chinese is the same symbol, and obviously this is at least not a crisis. I do not think you would use the word “crisis” yet, but certainly one that we are paying a lot of attention to. I wanted to raise, in addition to the WHO question I asked Dr. Heymann about what could be done to get more than just encouragement in participation, I wonder in the research area as well, Dr. Fauci. This is a wonderful opportunity in many ways for us to break through some of the resistance that may exist in certain quarters of the world, to share the kind of research that is being done at NIH with other leading research institutions around the globe to develop far more coordination and better co-

operation than exists today. Maybe it exists to a far greater extent than I am aware, but if it is not, how would you respond to that?

Dr. FAUCI. I think the degree of cooperation thus far, early on right now, has been quite extraordinary in a very positive sense. I think that if this serves as an example of what can be done, not only with other naturally occurring emerging and reemerging diseases, but in the event of bioterrorism. This could just as easily have been a microbe that was deliberately released. We are not 100 percent sure that it was not. It likely was not. But if it were, the mechanisms that got put into place to address this at the level of WHO, and at CDC, and our ability to mobilize the research enterprise, I think is a very good example. I would not say this would be a dry run, because it is substantial in and of itself. It is not a dry run for anything. It is real and it is serious, but it allows us to be able to show that the apparatus that we have put into place actually can work.

Senator DODD. Dr. Fauci has said that they are very much satisfied that this was not bioterrorism in any way. That has been the news reports I have read as well. Dr. Heymann, do you agree with that conclusion, there is no evidence that you have seen that this would be anything other than through natural causes, if you will?

Dr. HEYMANN. There is no evidence at present that this is anything but a naturally occurring infectious disease. But as Dr. Fauci has said, the mechanisms in place will deal with both the naturally occurring or deliberately caused infectious disease. And we have actually, as we have been revising the International Health Regulations, taken that into account. But there is no evidence.

Senator DODD. Mr. Chairman, I thank you immensely for holding this hearing. I think it is tremendously worthwhile, and I wonder if we might just keep the record open for a while here for any sort of recommendations from this hearing that these witnesses or others might bring to us as how we might legislatively, if there is such a role for us to respond to this in some way to encourage greater participation in response to these kind of situations. But I thank you for doing this.

The CHAIRMAN. We will certainly do that, Senator Dodd. Thank you.

Senator Sessions?

Senator SESSIONS. Thank you, Mr. Chairman, for this hearing. It is a fascinating hearing, and I am afraid with our highly mobile world we will be seeing more of these challenges in the future.

Dr. Heymann, you indicated that this has provided an opportunity to try out some of the new procedures I presume that you have adopted. What is your evaluation? How well has it worked?

Dr. HEYMANN. Well, I had to smile when Dr. Gerberding was telling how many people were working on this from CDC, because in Geneva we are doing this with 29 people, and it has been quite a strain on the systems that we have and on the staff that we have had. We have had some devoted staff working 24 hours a day in some instances to pull this off.

What we need to do now is to strengthen those systems to make sure that we have the staff available, because this will not come up every day, but when it does come up, it is time intensive, it is people intensive, and we need to make sure that we make the cor-

rect changes. We have one person coordinating all of the information and doing most of the interviews, a spokesman for WHO. We are very under equipped to do this type of activity, but we now have the chance to see where our inadequacies lie and how to move ahead faster because we want to be able to run the International Health Regulations proactively rather than passively as has been done in the past.

Senator SESSIONS. And I would understand that such a disease as this is not inevitable that it spread and that the sooner we act and the more vigorously we can act early, could limit the danger of a widespread epidemic; is that correct?

Dr. HEYMANN. That is correct. We have seen, after the alert went out on the 15th of March, the countries that had imported cases since then, had not the big health care worker and other epidemics the countries had before the 15th. Canada was the country which reported on the 14th, which stirred us to the international alert, and since then countries have been able to deal with this disease very effectively.

The only caveat that we do not know yet is whether or not this disease may occur in people who do not have symptoms, whether they are infected and do not have symptoms, and are spreading this around the world asymptotically. That we do not know yet, but we will know that as diagnostic tests become available.

Senator SESSIONS. Would either one of you like to comment on the questions I asked Dr. Heymann?

Dr. GERBERDING. I would just like to agree how important the lessons we have learned from the past have been in making this effort happen as quickly as it has. Two years ago I do not think we could have done this, but the investments that have been made in the public health infrastructure and the terrorism preparedness have really paid off. Every time we have an event like an anthrax attack or a West Nile investigation or a SARS outbreak, we also learn, and we improve, and I think we have improved tremendously, internationally as well as domestically over the last 2 years because of the major, major improvements in both the CDC's capacity but also the NIH's research capacity and the whole public health infrastructure. So we really thank you for your support and input.

Senator SESSIONS. Dr. Heymann, are you able to call Dr. Fauci and ask for help on research, for example, when something like this emerges?

Dr. HEYMANN. Yes, we are. We understand that there is a meeting in the U.S. this week on vaccine development, which we will be following very closely. We are very grateful that the U.S. takes the steps that they do, that keep the world on the cutting edge of new diseases.

Senator SESSIONS. Dr. Fauci, you work with other agencies and provide the research capability that may be needed to identify precisely what the disease is and how to fight it?

Dr. FAUCI. Yes, Senator Sessions. It is actually an ongoing collaborative effort. WHO, in fact David visited me in my office some months ago, talking about the interaction between WHO and emerging and reemerging diseases. We did not know, have any idea at the time that this would come up so soon thereafter. The

work that the CDC has done in jumping on this so rapidly and getting the proposed virus, which we feel reasonably sure is the virus, not only isolating it but getting it into the broader research enterprise so that we can do the kinds of vaccine, therapy and other work. I think it is an excellent example of how the research enterprise seamlessly goes back and forth with the public health enterprise. It should not be looked upon as two separate issues. There is the public health and then there is the research. They really are seamless, and there are some public health aspects of the research and some research aspects of the public health.

Senator SESSIONS. I agree with that so much, and I think we need to do a better job in Government of making sure our various agencies work together. We see it in the Defense Department. They are doing a lot better. We see it in Homeland Security, that are going to be working closer together, and it needs to be done here.

Dr. Fauci, to what extent are you able to positively identify this virus if a child in Massachusetts, the physician believes they may have it? Is it diagnosed by symptoms or is it diagnosed in the laboratory?

Dr. FAUCI. Well, I will just make one statement and then hand it over to Dr. Gerberding because they are working on a diagnostic test. Right now it is a syndromic diagnosis. Someone comes in with the fever, the typical physical findings, signs and symptoms with a epidemiological link to an exposure, that person is considered to have the syndrome. As we now, having the capabilities of isolating and identifying with diagnostic probes not only the virus but a response to the virus, that diagnosis will be much more definitive, but that is exactly what the CDC is working on right now.

Senator SESSIONS. Dr. Gerberding?

Dr. GERBERDING. Thank you. We have three tests that can be used to identify infection with coronavirus. The test that looks for the piece of the virus RNA in the patient's tissue specimens would help us diagnose cases early while the infection is still ongoing, and we are creating the primers for the molecular tests that need to go out to our laboratory research network and make that test available in public health laboratories. So we have got to make the reagents and then we have got to teach people how to do the test, though they already know how to do this technology.

The other two tests are based on antibodies that develop once you are infected. And the problem with that test is that when you first get sick, the test will be negative because your body has not had enough time to make an antibody. So we have to collect serum 3 weeks later after the onset of illness, and see that the test is positive. So it is helpful in saying, yes, this was a case of SARS, but it is not helpful up front in knowing who has it and who does not, or who needs to be isolated or who does not.

So we are going to be working with FDA to get these tests into a form where they would be useful diagnostically in individual patients. Right now they are primarily a tool for determining where are the cases and what can we learn about spread and how effective our containment methods are.

I will just say that the fact that this has happened in just a few weeks period of time, really, 2 weeks since we have had the virus and begun to work on it are we able to do this kind of diagnostic

testing, is an unbelievable achievement in science. It would not have, again, have happened without the 11 international laboratories that WHO has put into this collaborating network. These people have a daily conference call. They have a secure website, and they truly are exchanging information in real time, so we have been able to accelerate the whole process of virus discovery and testing.

Senator SESSIONS. If someone does contract the virus, what can you tell us about the normal treatment process, how often and how long might they expect to be in the hospital, and what kind of cost would that present the United States, for example, if it became as widespread as a flu epidemic?

Dr. GERBERDING. The data we have right now suggests that there is a spectrum of illness associated with this virus, and it is possible that some people have very mild infections that would not normally require health care, although they could pose a risk of transmission to others.

The people who get the pneumonia often are quite ill and require hospitalization, and in some cases mechanical ventilation. Those are of course people who have the most serious illness and are most likely to die from the infection, but the majority of people do recover.

Unfortunately, sometimes it takes many days to a few weeks to really get back to baseline, and some of the people who have been the sickest are improving, but they are still not back to the way they were before they got ill. So a full recovery is possible, and we hope that ultimately will be the case for everyone, but it can be a long time in coming.

Senator SESSIONS. In terms of prevention, prevention is certainly the best policy financially as well as health care wise, I am sure.

Dr. Heymann, we had a very interesting hearing here last week with Dr. Gisselquist who did a study on the transmission of AIDS in Africa, a very provocative proposal that suggests that WHO's numbers from health care transmissions, that is by needles and injections, and HHS's numbers, were below what he thinks the studies show. Have you had a chance to personally look at that? And would you give it a study, because it would make I think a significant difference if he were even partially correct in how we deal with the transmission of AIDS in Africa?

Dr. HEYMANN. In the 1990s we did studies in Uganda and in Zimbabwe, which showed that transmission to midwives, nurse midwives and others was important, and some of the variables, some of the reasons were because they stuck their fingers with needles as they were doing procedures.

From the evidence that we have though in Africa, the majority of transmission is sexual transmission, and that has remained constant throughout the studies that have been done. It is a sexually transmitted disease first and foremost, which does affect all persons, and then is transmitted unfortunately from pregnant women to their children in many instances. There is also transmission by needle and syringe as well.

Senator SESSIONS. I hope you would just take a look at that new study, and I would yield.

Dr. HEYMANN. Be glad to.

Senator SESSIONS. Good.

The CHAIRMAN. Thank you, Senator Sessions.

We will do a second round here. Can you tell us, Dr. Heymann, whether China has adequately quarantined Guangdong Province and Hong Kong or whether they need to do more?

Dr. HEYMANN. It seems that Guangdong was the source of infection for Hong Kong. Right now on people who are leaving Guangdong by train or by airplane, they are given a card with the symptoms of the disease, and they are told that they should see a health worker if they have that disease. There is not much more that can be done at present in there except cordoning the area off. We have done that internationally by asking travelers not to travel to that area if it is not necessary, voluntarily, because we do not understand enough about the disease.

We feel that China is taking the measures now that they can. If these measures had been taken in November perhaps the disease would not have spread.

The CHAIRMAN. Just generally, what is the death rate that they are experiencing in China from people that would be infected; do you know?

Dr. HEYMANN. The death rate in China is the same as it is in other countries, between 3.5 and 4 percent of all people who were infected.

The CHAIRMAN. Dr. Fauci, where do we stand with the vaccine effort, developing a vaccine? Obviously it takes a long time to develop a vaccine, but you were, as you said, phenomenally quick in developing identifier capability, diagnostics. And I am wondering first, what do you see as a time frame for a potential vaccine? What are the problems with developing vaccines? Do we have enough of a vaccine industry to do it in the United States, an issue which we are going to be revisiting later this week? Do we expect this to mutate? You mentioned that this may, because of its structure, mutate into an even more difficult disease to deal with.

Dr. FAUCI. With regards to vaccine effort, Senator, for this particular virus, as you know, vaccines take years and years, and they are generally generations of vaccine. The point that I made briefly in my opening statement is that the good news about this is that the microbe is growing in a cell line, it is culturable, so you get enough of it if you rev it up and scale it up to do what would be like a first generation of a vaccine, namely just take it, kill it, go in an animal model and see if you vaccinate the animal and then challenge the animal, first a mouse, then a monkey, and show what we call proof of concept, that you can actually protect some species against this with a vaccine.

If we talk about that, that will likely, if we are lucky, take several months to do that. To get that then translated into a first generation vaccine for humans, will without a doubt take longer than a year. I do not think there is any chance that we are going to have a vaccine this time next year. Likely within a period a bit longer than a year. And that is if we are lucky.

But that is not going to be 10 years. The reason we say that is the concept that, (A) it is growing, (B) there are coronavirus vaccines that have been successful in animal. When I say vaccine—and that will get to your second question—that does not mean we

will necessarily have enough of it to give to everyone, but we would be able to at least get into some human trials within a period a little bit greater than a year. The success of showing that that candidate is a usable virus for distribution, I cannot predict how long that will take.

With regard to industry, this is another example of what we had discussed several times, is the importance of getting industry involved early, because we can do those first steps. We can even take it to the point of pre-advanced development. But when you get to the point of advanced development in a vaccine, you need the interested industry involved, because the killed vaccine that I mentioned is just the first generation. There is the vector type vaccines, the DNA vaccines, and then the possibility of live attenuated vaccines, each of which have the potential for a greater degree of efficacy. So it is a process the you have to measure over years.

The final question that you mentioned about mutating, coronaviruses are RNA viruses. They have a very bad what we call proofreading mechanism when they replicate, so they have the possibility of naturally being very heterogenous and variable. Is it possible that this virus that is now in the community will mutate some more? Sure, there is the possibility and very likely that it will mutate. Will it mutate to the point where it changes any of the relevant functions that are going on right now? Unlikely because it usually takes a longer period of time interacting among different men, women in the society before you start seeing mutations that are clinically relevant. So I think ultimately there is the possibility, given the nature of the virus, to ultimately start mutating, but at this early stage of its jumping into humans, it would have to be a little bit more adapted before you functionally mutate to the point of having a difference.

The CHAIRMAN. Thank you. It just shows we need to pass that Dodd-Frist Vaccine Bill.

Senator DODD. I think he calls it Frist-Dodd, but I take your point.

The CHAIRMAN. Senator Kennedy?

Senator KENNEDY. Let me ask you, Dr. Gerberding, what are the symptoms? We tried in the earlier round to ask you what people might be able to do. But could you tell us about the symptoms for the people that are watching or hearing this? How is this different from the flu?

Dr. GERBERDING. Well, the short answer is that it does not differ very much from the flu. It is pretty much the typical viral like illness when it starts. We have a hint that it kind of has a biphasic pattern, so you get—

Senator KENNEDY. Do you want to just describe that again? I think most of us know what the flu is about, but just so people are reminded about it?

Dr. GERBERDING. Not everyone starts off with a fever, but they usually feel tired. They have muscle aches. They have a sore throat, and then usually a fever develops. Sometimes headache is a prominent feature. In a few people they have that early illness and then the fever goes away, and then that is followed by coughing and sort the pneumonia type symptoms of the chest pain, the tightness, progressing to the troubled breathing. But in the

very earliest days it looks like any other kind of common cold or common viral illness. What you have to know is that you have been either a traveler or you have been exposed, and if you have those very early symptoms you need to contact your health care professional.

Senator KENNEDY. At present what is the best treatment for SARS?

Dr. GERBERDING. There are nonspecific treatments, which particularly for the people who have pneumonia include making sure that they are hydrated, that they have good nutrition, good nursing care and so forth. But because at the beginning we often cannot tell it apart from other common causes of pneumonia, many patients will need to be on antibiotics in case we are wrong, it is regular old pneumococcal pneumonia or something. Some patients have been treated with anti-flu, antiviral medications.

In terms of specific treatment for SARS or for coronavirus or for other viruses, per se, there is not any. Many clinicians globally have tried ribavirin. The results are not in, but I do not think it looks real promising right now for that to be a solution. Some other things have been tried, and it is just anecdotal and far too soon. We do have already an investigational new drug protocol developed to look at ribavirin treatment more systematically to see if it is offering anything. The results of the work that is going on in screening antiviral drugs will help guide future protocols. I think we will have things to try in the future, but right now we do not have much on the shelf that makes sense.

Senator KENNEDY. Dr. Fauci talked about vaccine development. What about a diagnostic test? Can you tell us when you think that might be available?

Dr. GERBERDING. Last week we distributed the first test results to State Health Departments with case patients in the United States. We cannot sensibly give test results until we have that second day-21 sample, and since so many of our cases are just now coming into that epidemiology curve, it is too soon to interpret anything, especially the negatives at this point in time. We expect over the next couple of weeks that we will be getting at least some of the test reagents out broadly.

Senator KENNEDY. That is very encouraging and should be to all public health professionals, that these kinds of tests are going to be out and available in a very short period of time. It will be enormously valuable and helpful to them I would expect.

Dr. GERBERDING. We are hoping that will prove to be the case. Of course we have to test uninfected people and we have to test really very sick people, and then the kind of mixed picture in between to really know how sensitive are these tests, how specific are these tests, and overall, what does a specific test mean in a given individual? And that is where I think FDA will help us go through the process of really validating this for individual patient use.

Senator KENNEDY. And they are obviously working with you now.

Dr. GERBERDING. Absolutely. Actually, Secretary Thompson has pulled together a departmental working group on this with NIH and FDA and CDC, and we are part of a team pulling together the reagent development as well as the vaccine product development.

Senator KENNEDY. Let me ask Dr. Heymann, are other countries working on the diagnostic tests or the vaccines?

Dr. HEYMANN. On the diagnostic tests, test are being developed in Hong Kong. Singapore is working on some different tests, as are laboratories in Germany, and also in other laboratories around the world. So in these 11 laboratories that are collaborating, they are also working. The beauty is that they are exchanging their information so that they are getting results faster.

Senator KENNEDY. That is important. And vaccine, anything going on in Europe at this time or any of the other—

Dr. HEYMANN. The only thing with vaccine at this point is in the United States, as far as we know.

Senator KENNEDY. Dr. Fauci, this is, you believe, a coronavirus? Earlier there was some question about whether it might be or might not be.

Dr. FAUCI. Right.

Senator KENNEDY. You believe considering the science to date is that is what it is?

Dr. FAUCI. The virus that the CDC and others have isolated is unquestionably a coronavirus. The evidence, absolutely 100 percent that this is causing it is almost there, but not 100 percent yet. We are assuming it is. All of the work that I described is I am confident enough to make the investment to go ahead with the research that is assuming this.

Senator KENNEDY. Well, that is reassuring and I thank you.

Finally, the President signed the Executive Order on quarantine. What is that going to mean to people? Can you explain it to us and to the American people, what that might mean, somebody coming back from China and they have been interested his area? What are their chances, or if they are getting the quarantine, what will this mean to them and how widely do you anticipate that this might be used?

Dr. GERBERDING. First of all, right now we are not quarantining anyone in the United States, and we are not planning to quarantine anyone, given what we are seeing right now.

What the Executive Order does, it gives the authority to quarantine for SARS in the same way that we can quarantine for other communicable diseases like cholera already. So it is just simply a matter of adding SARS to a list of diseases that already, if necessary, we can take action to prevent spread within the community. So it is a precaution, a just-in-case kind of Executive Order.

Senator KENNEDY. I want to thank you all. This has been enormously interesting, very helpful.

I must say, Mr. Chairman, I think this is very reassuring for the American people. As Dr. Gerberding had pointed out, and in articles about it, there is enormous concern, in my State it is, and all across this country. And I think the reassurance that the American people should have with the fact that we have been on this so quick with the leadership of the World Health Organization, the NIH already moving with the vaccines, Dr. Gerberding and the communication of working with public health groups. The American people ought to understand that this is a danger, but our leading health research agencies, including the FDA, are working on

this, and we have really the best in the world that are working on it.

There are going to be others who probably will be infected and some will lose their lives, but I think the American people should be very reassured that we have the best working on it and dealing with it in an important scientific way, and help is on its way.

I thank you, Mr. Chairman.

The CHAIRMAN. That is a very soothing comment.

Senator Dodd, do you have any additional questions?

Senator DODD. Just a couple of brief ones just to follow up on that point.

It is always the unknown that is always the most frightening, and so by sharing with us your thoughts here today, that does a great deal to help.

Just a couple of quick questions. We had at least a suspected case in Connecticut, at the University of Connecticut, a student. It occurred to me reading the articles again today because they are following up with that, we received a tremendous number of calls from other universities just to know how the university handled that particular case.

How difficult is it to identify this based on the coronavirus cell you had up here with a crowning effect and so forth? Is it that hard to identify in people? Are there a number of suspected cases? How does that differ from the known cases? What are the numbers like here? Is there a great differential between suspected cases and known cases?

Dr. GERBERDING. In the United States we have decided to lump everybody together in the suspected case under investigation category because we think that is the best way to help contain spread from even the less suspicious individuals. The reason that we cannot get a picture like that for every patient is that that picture came from an electron microscope, and it is very difficult to get virus out of tissue through noninvasive strategy. If we could do a lung biopsy on everyone early in illness, we would probably be able to find this virus, but we cannot do that. So mostly we have had to rely on autopsy tissues, and fortunately we have not had a lot of those to deal with. So we can see the virus in tissue but not very often.

Senator DODD. That makes the problem that much more difficult in a sense then?

Dr. GERBERDING. That is why we are relying on these indirect tests like the antibody test. If someone has a negative test when they come in and their antibody test becomes positive, it is really strong evidence that they have been infected with this agent. We know that the tests are looking very specific, meaning that we have tested them on 300 or so people with no illness related to SARS and the test is always negative in those people. So when we see it coming up in the course of illness, that is a really strong clue of causality, and we are just looking at more people to make sure we can say that with reliability across the board.

Senator DODD. Is the question that Senator Kennedy raised about what are you doing at this point with people who you suspect have SARS, is providing some sort of treatment here in any way

producing its own set of problems in any of these patients at all that you have been able to identify?

Dr. GERBERDING. It is important to appreciate that when people are sick with pneumonia in hospitals, particularly if they are on a mechanical ventilator, lots of other complications can develop in addition to the damage that the virus is causing per se. One of the reasons why we are very cautious about recommending treatment when we have no idea whether it is useful, is that there are side effects. For example, there are side effects to ribavirin that can be very serious, such as anemia and other complications. So we want to do that in a very careful way so that we protect the patients from the harmful effects of what would really be experimental treatment at this point.

Senator DODD. Do you have any idea what the gestation period is between exposure and coming out with the symptoms, based on again a limited number? Dr. Heymann, jump in here too if you have some additional information. But what are we looking at here between exposure and actually getting symptoms? Do you have any idea of that at all?

Dr. GERBERDING. It has been difficult to say in specific individual cases. Right now we are operating under the assumption that it is somewhere between two and 10 days, but recently there have been a couple of anecdotal reports that suggest maybe the incubation period could be a day or two longer than that.

Senator DODD. And again, any patterns developing here about age and so forth? I have read where it seems as though some of the cases of fatalities it was older patients, although I then saw some information that said even very young patients. I am wondering if there is anything emerging here that would show at this point, that you feel confident enough to share with us in terms of some conclusions? Again, I understand that you want to be careful, but I wonder if anything that you have been able to discern at this point leads you to a particular set of conclusions about this.

Dr. GERBERDING. Right now the data suggests that the most common age of acquiring this infection is sort of middle age, like around age 50, and men and women seem to be more or less equally affected, although in health care settings where there are more women health care workers, there will be potentially more women cases in those settings. I think Dr. Heymann probably can give you the global picture on how that pans out.

Senator DODD. How is that doing, Dr. Heymann, just quickly on this?

Dr. HEYMANN. In Singapore there are now three children who had the disease. But now that we have access to the Chinese data, which is 4 months worth of data, we will rapidly know whether or not this disease did remain in adults, who were the first infected because they are health workers, or if it does also occur in children. We believe it does because it spreads from parents to their children, the parents being health workers. And then we do not know what happens in the community after that. We believe we will know after we have finally been able to analyze all of the Chinese data.

Senator DODD. How much follow up is occurring with those who have emerged, assumed, suspected they even had SARS, and then

apparently been able to recover fairly quickly from it? Following those people afterwards to determine, to stick with them, it seems to me that their immune system or something about their genetic makeup would be worthwhile to know? Are we following up? Are we doing that?

Dr. GERBERDING. Dr. Gerberding. At CDC we have something called Team B, which is a group of people we have asked to step aside from being involved in this day to day and to think about the kinds of questions that you are bringing up so that we know that we are asking and being prepared to answer these scientific questions. We are creating a protocol for the long-term follow up of people after SARS. Simple things we need to know. Do they still have the virus; you know, is there a carrier state? Why do some people get sick and some people do not get sick? How long does it take for full recovery? How many people do not have full recovery? There is a lot to learn as we go forward.

Senator DODD. And two last questions. One is, you talked about the group that is organizing here. What about the companies themselves? It seems to me the pharmaceutical industry, to what extent are you involving them and their research activities in what you are doing so that they are very much a part of this collaborative effort?

Dr. FAUCI. We are reaching out to the pharmaceutical industry in the arenas of not only vaccines but in also in therapeutics, asking them if they have compounds on their shelf, some of which are just screened compounds, and some of which might mechanistically have a possibility of blocking the virus.

Right from the get-go we made it very clear in our interactions with industry that we are willing, and want to very much outreach with them in the areas of vaccines, therapeutics and also diagnostics.

Senator DODD. Is that unique in this regard? Because of this set of circumstances—is this normally something you would do with a similar kind of situation, other similar situations, obviously a little different than this, or is this something that you would be doing that is fairly unique in that regard?

Dr. FAUCI. I would not say it is unique, Senator, but I would say that over the past few years, particularly in the activity that has now evolved vis-a-vis the need for farmer as well as biotech companies, in the development of countermeasure for biodefense, has kind of shook the ground a bit, that we really do need to have a good collaboration between industry and academia and Federal law and international organizations.

So although we have done that in the past, the fact that it is happening now so quickly I think is a testimony to the realization that no one can really do it alone. We do need industry there.

Senator DODD. I understand that. And I wonder if there are some problems—and you may not be able to answer this right now just with regard to proprietary information and the unwillingness of companies sharing the kind of information that they might feel could end up in the public domain in some way. Is that a problem?

Dr. FAUCI. Well, that sometimes is a problem, but that is a problem not only with companies. We just have to deal with it.

Senator DODD. Last, let me ask you this. If you are looking at this situation—again, everything you have said here, the important thing about this hearing I think additionally to this specific information is that the worse thing that could happen right now is for a panic or an alarmist situation to take over. But I just want to have a degree of confidence. In light of the fact that this may become a more serious problem, are you planning on steps, doctor, to take if this thing emerges over the next number of weeks, we found an exponential growth? Are you thinking ahead?

Dr. GERBERDING. Yes. We absolutely are thinking ahead. The kinds of things that Dr. Fauci has been talking about in terms of antivirals or vaccines are way down the road, and so we have got to be prepared to do what we can do now. Detection is critical, and we have made major investments in detection for terrorism, but we are scaling those up. Getting the tests out, so we know who has it and who does not, that is a very high priority for us. If we see ongoing spread, for example, if we get into a situation like Canada, where there is widespread transmission within a hospital, we will act quickly to close the hospitals to new admissions and cohort the health care workers and patients because we know what will happen if we do not. We have learned by watching the experience elsewhere.

Similarly, if we saw a situation where there was a danger to a school or some other kind of scenario, we would take what is I think very sensible guidance right now, and we will add steps to help people avoid transmitting to others while they are sick.

So there is more we can do if we need to.

Senator DODD. And do you have enough resources at this juncture, looking ahead, do you think to handle all of that in personnel?

Dr. GERBERDING. Right now I think we are right on target.

Senator DODD. Dr. Heymann, just curious whether you and the World Health Organization, the image of 29 people, should this grow to be a more serious problem, do you have adequate personnel, resources and so forth to be able to handle this?

Dr. HEYMANN. Yes. Our Director General has agreed that she will shift resources to this should we need them. So we are in the process of looking at how we can shift our budget to deal with this problem and to keep the people and the staff that we need.

What we also depend on is people coming in from other agencies or other countries, and CDC again has helped us in that respect in detailing people to WHO to work on specific issues of this outbreak.

Senator DODD. Thank you.

The CHAIRMAN. Thank you very much, Senator Dodd.

Once again, on behalf of myself and the committee, and I know Senator Kennedy, we certainly appreciate you taking the time to come here.

We want to thank you, Dr. Heymann, for taking your time late in the afternoon or maybe early evening in Geneva, and giving us the time you have, and we especially want to thank the World Health Organization for the extraordinary job you have done on this threat to the world community generally.

Dr. Fauci, NIH always does a great job, and Dr. Gerberding, the same with CDC. We appreciate the fact that you are so expert and

that you give us the confidence that, as Senator Kennedy said, here in the United States we have a health community which is on top of the issue and is aggressively pursuing the protections America needs. So thank you, and we appreciate your time.

The meeting is adjourned.

[Additional material follows.]

ADDITIONAL MATERIAL

PREPARED STATEMENT OF JULIE L. GERBERDING, M.D.

Good morning, Mr. Chairman and Members of the Committee. I am Dr. Julie L. Gerberding, Director, Centers for Disease Control and Prevention (CDC). Thank you for the invitation to participate today in this timely hearing on a critical public health issue: severe acute respiratory syndrome (SARS). I will update you on the status of the spread of this emerging global microbial threat and on CDC's response with the World Health Organization (WHO) and other domestic and international partners.

As we have seen recently, infectious diseases are a continuing threat to our nation's health. Although some diseases have been conquered by modern advances, such as antibiotics and vaccines, new ones are constantly emerging, such as Legionnaires' disease, Lyme disease, and hantavirus pulmonary syndrome. SARS is the most recent reminder that we must always be prepared for the unexpected. SARS also highlights that U.S. health and global health are inextricably linked and that fulfilling CDC's domestic mission—to protect the health of the U.S. population—requires global awareness and collaboration with international partners to prevent the emergence and spread of infectious diseases.

EMERGENCE OF SARS

Since late February 2003, CDC has been supporting WHO in the investigation of a multi-country outbreak of unexplained atypical pneumonia referred to as severe acute respiratory syndrome (SARS). As of April 3, 2003, a total of 2300 probable or suspected cases of SARS have been reported to WHO from 16 countries, and 79 of these patients have died. This includes 115 suspected cases in the United States, from 29 states. None of the suspected cases in the United States have died.

In February, the Chinese Ministry of Health notified WHO that 305 cases of acute respiratory syndrome of unknown etiology had occurred in Guangdong province in southern China since November 2002. In February 2003, a man who had traveled in mainland China and Hong Kong became ill with a respiratory illness and was hospitalized shortly after arriving in Hanoi, Vietnam. Health-care providers at the hospital in Hanoi subsequently developed a similar illness. During late February, an outbreak of a similar respiratory illness was reported in Hong Kong among workers at a hospital; this cluster of illnesses was linked to a patient who had traveled previously to southern China. On March 12, WHO issued a global alert about the outbreak and instituted worldwide surveillance for this syndrome, characterized by fever and respiratory symptoms.

On Friday, March 14, CDC activated its Emergency Operations Center (EOC) in response to reports of increasing numbers of cases of SARS in several countries. On Saturday, March 15, CDC issued an interim guidance for state and local health departments to initiate enhanced domestic surveillance for SARS; a health alert to hospitals and clinicians about SARS; and a travel advisory suggesting that persons considering nonessential travel to Hong Kong, Guangdong, or Hanoi consider postponing their travel. HHS Secretary Tommy Thompson and I conducted a telebriefing to inform the media about SARS developments.

Of the 115 reported suspected cases among U.S. residents, 109 have traveled to mainland China, Hong Kong, Singapore, or Hanoi, Vietnam, 4 had household contact with a suspected case, and 2 are healthcare workers who provided medical care to a suspected case. Cases in the United States have had relatively less severe manifestations of SARS, compared to cases reported in other countries. Forty-three cases have been hospitalized. As of April 3, 12 remain in the hospital, and none have died. Community transmission of SARS has not been identified within the United States. Transmission to healthcare workers has only been observed in one cluster involving two healthcare workers in the United States, in contrast to the numerous instances of possible transmission to healthcare workers that have been reported in several other countries.

Cases of SARS continue to be reported from around the world. The disease is still primarily limited to travelers to Hong Kong, Hanoi, Singapore, and mainland China; to health care personnel who have taken care of SARS patients; and to close contacts of SARS patients. Based on what we know to date, we believe that the major mode of transmission is through droplet spread when an infected person coughs or sneezes. However, we are concerned about the possibility of airborne transmission and also the possibility that objects that become contaminated in the environment could serve as modes of spread.

CDC RESPONSE TO SARS

CDC continues to work with WHO and other national and international partners to investigate this ongoing emerging global microbial threat. This is a major challenge, but it is also an excellent illustration of the intense spirit of collaboration among the global scientific community to combat a global epidemic.

CDC is participating on teams assisting in the investigation in mainland China, Hong Kong, Taiwan, Thailand, and Vietnam. In the United States, we are conducting active surveillance and implementing preventive measures, working with numerous clinical and public health partners at state and local levels. As part of the WHO-led international response thus far, CDC has deployed approximately 30 scientists and other public health professionals internationally and has assigned almost 300 staff in Atlanta and around the United States to work on the SARS investigation.

CDC has issued interim guidance to protect against spread of this virus for close contacts of SARS patients, including in health care settings or in the home. We have also issued interim guidance for management of exposures to SARS and for cleaning airplanes that have carried a passenger with suspected SARS. We have issued travel advisories and health alert notices, which are being distributed to people returning from China, Hong Kong, Singapore, and Vietnam. We have distributed more than 200,000 health alert notice cards to airline passengers entering the United States from these areas, alerting passengers that they may have been exposed to SARS, should monitor their health for 10 days, and if they develop fever or respiratory symptoms, they should contact a physician.

WHO is coordinating daily communication between CDC laboratory scientists and scientists from laboratories in Asia, Europe, and elsewhere to share findings, which they are posting on a secure Internet site so that they can all learn from each other's work. They are exchanging reagents and sharing specimens and tissues to conduct additional testing. Our evidence and that of many of our partners indicates that a new coronavirus is the leading candidate for the cause of this infection.

Initial laboratory efforts were focused on a diagnosis based on clinical symptoms and available epidemiologic information. On the basis of this initial diagnosis, CDC used classical microbiologic approaches and molecular diagnostic methods to identify the agent or agents involved. A broad range of pathogens primarily associated with respiratory disease and for which respiratory symptoms might be secondary were targeted for detection in SARS specimens. Various methods were used for detection, including light and electron microscopy, immunohistochemistry, cell culture isolation techniques, serology, and other modern molecular techniques. An apparently new coronavirus was isolated in cell cultures, and coronavirus nucleotide sequences specific to this virus were detected in diseased tissues. This finding, coupled with the increasing reports that many WHO collaborating laboratories have detected this virus in specimens from SARS patients, suggests that this coronavirus is involved in the etiology of the disease. Efforts to further characterize the role of this coronavirus in SARS are ongoing at CDC and in other laboratories.

Rapid and accurate communications are crucial to ensure a prompt and coordinated response to any infectious disease outbreak. Thus, strengthening communication among clinicians, emergency rooms, infection control practitioners, hospitals, pharmaceutical companies, and public health personnel has been of paramount importance to CDC for some time. In the past three weeks, CDC has had multiple teleconferences with state health officials to provide them the latest information on SARS spread, implementation of enhanced surveillance, and infection control guidelines and to solicit their input in the development of these measures and processes. On Friday, April 4, WHO sponsored, with CDC support, a clinical video conference broadcast globally to discuss the latest findings of the outbreak and prevention of transmission in healthcare settings. The faculty was comprised of representatives from WHO, CDC, and several affected countries who reported their experiences with SARS. The video cast is now available on-line for download. Secretary Thompson and I, as well as other senior scientists and leading experts at CDC, have held numerous media briefings to provide updated information on SARS cases, laboratory and surveillance findings, and prevention measures. CDC is keeping its website current, with multiple postings daily providing clinical guidelines, prevention recommendations, and information for the public.

PREVENTION MEASURES

Currently, CDC is recommending that persons postpone non-essential travel to mainland China, Hong Kong, Singapore, and Hanoi, Vietnam. Persons who have traveled to affected areas and experience symptoms characteristic of SARS should

contact a physician. Health care facilities and other institutional settings should implement infection control guidelines that are available on CDC's website.

We know that individuals with SARS can be very infectious during the symptomatic phase of the illness. However, we do not know how long the period of contagion lasts once they recover from the illness, and we do not know whether or not they can spread the virus before they experience symptoms. The information our epidemiologists have suggests that the period of contagion may begin with the onset of the very earliest symptoms of a viral infection, so our guidance is based on this assumption. SARS patients who are either being cared for in the home or who have been released from the hospital or other health care settings and are residing at home should limit their activities to the home. They should not go to work, school, or other public places until at least ten days after they are fully asymptomatic.

If a SARS patient is coughing or sneezing, he should use common-sense precautions such as covering his mouth with a tissue, and, if possible and medically appropriate, wearing a surgical mask to reduce the possibility of droplet transmission to others in the household. It is very important for SARS patients and those who come in contact with them to use good hand hygiene: washing hands with soap and water or using an alcohol-based hand rub frequently and after any contact with body fluids.

For people who are living in a home with SARS patients, and who are otherwise well, there is no reason to limit activities currently. The experience in the United States has not demonstrated spread of SARS from household contacts into the community. Contacts with SARS patients must be alert to the earliest symptom of a respiratory illness, including fatigue, headache or fever, and the beginnings of an upper respiratory tract infection, and they should contact a medical provider if they experience any symptoms.

EMERGING GLOBAL MICROBIAL THREATS

Since 1994, CDC has been engaged in a nationwide effort to revitalize national capacity to protect the public from infectious diseases. Progress continues to be made in the areas of disease surveillance and outbreak response; applied research; prevention and control; and infrastructure-building and training. However, SARS provides striking evidence that a disease that emerges or reemerges anywhere in the world can spread far and wide. It is not possible to adequately protect the health of our nation without addressing infectious disease problems that are occurring elsewhere in the world.

Last month, the Institute of Medicine (IOM) published a report describing the spectrum of microbial threats to national and global health, factors affecting their emergence or resurgence, and measures needed to address them effectively. The report, *Microbial Threats to Health: Emergence, Detection, and Response*, serves as a successor to the 1992 landmark IOM report *Emerging Infections: Microbial Threats to Health in the United States*, which provided a wake-up call on the risk of infectious diseases to national security and the need to rebuild the nation's public health infrastructure. The recommendations in the 1992 report have served as a framework for CDC's infectious disease programs for the last decade, both with respect to its goals and targeted issues and populations. Although much progress has been made, especially in the areas of strengthened surveillance and laboratory capacity, much remains to be done. The new report clearly indicates the need for increased capacity of the United States to detect and respond to national and global microbial threats, both naturally occurring and intentionally inflicted, and provides recommendations for specific public health actions to meet these needs. The emergence of SARS, a previously unrecognized microbial threat, has provided a strong reminder of the threat posed by emerging infectious diseases.

CONCLUSION

The SARS experience reinforces the need to strengthen global surveillance, to have prompt reporting, and to have this reporting linked to adequate and sophisticated diagnostic laboratory capacity. It underscores the need for strong global public health systems, robust health service infrastructures, and expertise that can be mobilized quickly across national boundaries to mirror disease movements. As CDC carries out its plans to strengthen the nation's public health infrastructure, we will collaborate with CDC Response to SARS state and local health departments, academic centers and other federal agencies, health care providers and health care networks, international organizations, and other partners. We have made substantial progress to date in enhancing the nation's capability to detect and respond to an infectious disease outbreak; however, the emergence of SARS has reminded us yet again that we must not become complacent. We must continue to strengthen the

public health systems and improve linkages with domestic and global colleagues. Priorities include strengthened public health laboratory capacity; increased surveillance and outbreak investigation capacity; education and training for clinical and public health professionals at the federal, state, and local levels; and communication of health information and prevention strategies to the public. A strong and flexible public health infrastructure is the best defense against any disease outbreak.

Thank you very much for your attention. I will be happy to answer any questions you may have.

PREPARED STATEMENT OF ANTHONY S. FAUCI, M.D.

Mr. Chairman and Members of the Committee, thank you for the opportunity to discuss the research activities of the National Institutes of Health (NIH) that promise to help us better understand and counter the global outbreak of Severe Acute Respiratory Syndrome, or SARS. I am pleased to share this table with Dr. Julie Gerberding, the Director of our sister agency, the Centers for Disease Control and Prevention (CDC), which has done such an extraordinary job in responding to the evolving epidemic.

As Dr. Gerberding will discuss in some detail, SARS rapidly has moved across the globe, becoming a worldwide health emergency that has resulted in quarantines, travel warnings, and mounting economic damage. The global tally of SARS cases has grown to more than 2,300 cases in only six weeks since the apparent emergence of the disease. At this early stage of the epidemic, it is impossible to predict whether SARS will become an ongoing, major global health threat, or if the epidemic will spontaneously burn out or be contained by public health measures. However, we must be prepared for the worst-case scenario.

Dr. Gerberding and her CDC team, together with the World Health Organization (WHO) and others, have done a magnificent job in identifying and tracking this epidemic, illuminating the etiology and clinical features of SARS, and providing the world with information about the epidemic in real time. Complementing the efforts of the CDC and WHO, the National Institute of Allergy and Infectious Diseases (NIAID), a component of NIH, also has a significant role in the efforts against SARS, notably by rapidly addressing the issues of vaccine development, drug screening, and clinical research.

As with Lyme disease, Hepatitis C, HIV/AIDS, Ebola, West Nile virus and a host of other "new" diseases, the SARS outbreak has reminded us that the emergence or reemergence of infectious diseases is a constant threat. As has been the case with other emerging diseases, we anticipate that the strong NIAID research base in disciplines such as microbiology, immunology and infectious diseases will facilitate the development of interventions such as diagnostics, therapies, and vaccines to help counter SARS.

As described by CDC and WHO, evidence is mounting, although not yet definitive, that SARS is caused by a novel coronavirus that may have crossed species from an animal to humans. This hypothesis is based on the detection and isolation of coronaviruses from unrelated patients from different countries, and on the finding that several SARS patients have mounted an immunological response to coronavirus as they proceeded from the acute illness to the recovery or convalescent stage. While some questions remain—for example, there is some evidence that a second virus may contribute to the pathogenesis of SARS—the strong evidence for a causative role for a coronavirus justifies the ongoing development of diagnostic tools, therapies and vaccines that target coronaviruses.

Coronaviruses are best known as one of the causes of the "common cold," which is generally a very benign condition, very rarely resulting in life-threatening disease. The coronavirus that has been shown to be associated with SARS is a new type of coronavirus that has not been previously identified.

I would note that no evidence of genetic "tampering" of the virus implicated in SARS has been detected, based on analyses of the mounting genomic sequence data of the samples from SARS patients examined so far. As even more extensive genomic sequence data become available for the SARS virus, it will be possible to further distinguish natural origin from the possibility that the SARS agent was created in a laboratory or even as a bioweapon. Until then, we will keep our minds open to these possibilities, however remote.

NIAID RESEARCH ON SARS

NIAID maintains a longstanding commitment to conducting and supporting research on emerging infectious diseases, such as SARS, with the goal of improving global health. In carrying out its global health research mission, the Institute supports a myriad of activities, including intramural and extramural research, and col-

laborations with international agencies and organizations. Since the first SARS reports, NIAID has worked rapidly to identify opportunities for accelerating or expanding research to improve the diagnosis, treatment, and prevention of SARS. These areas include:

Surveillance and epidemiology.

NIAID supports a long-standing program for surveillance of influenza viruses in Hong Kong, led by Dr. Robert Webster of St. Jude's Children's Research Hospital in Memphis. Dr. Webster and his team in Hong Kong have collaborated with WHO, CDC and others in helping to illuminate the SARS outbreaks in Asia. In addition, at the request of WHO, NIAID assigned a staff epidemiologist to provide epidemiologic and logistical assistance during the early stages of the epidemic.

Diagnostics.

As discussed by Dr. Gerberding, significant progress has been made by the CDC in developing a diagnostic test for SARS. As part of these efforts, NIAID-sponsored researchers in Hong Kong also devised a diagnostic test based on PCR technology as well as a diagnostic tool using the immunofluorescence assay technique. In other research, the NIAID-funded Respiratory Pathogens Research Unit (RPRU) at Baylor College of Medicine has developed methods to detect known human coronaviruses using cell culture and molecular diagnostic tools and can also assess the host immune response to known coronavirus infections. In 2003 NIAID will expand this capacity for research on emerging acute viral respiratory diseases, including pandemic influenza and SARS.

Vaccine Research.

As the SARS epidemic continues, it will be necessary to consider a broad spectrum of vaccine approaches, as well as immunotherapy. NIAID is supporting the rapid development of vaccines to prevent SARS through both our extramural and intramural programs, including the NIAID Vaccine Research Center. Initially, these efforts are focusing on the development of an inactivated (or killed) virus vaccine. However, other approaches will soon follow, including novel approaches such as vector-based and recombinant vaccines, DNA-based vaccines and live attenuated vaccines, as more knowledge about the cause of SARS and its etiology becomes available.

NIAID scientists have received samples of the SARS coronavirus from CDC and have initiated efforts to develop a vaccine. Fortunately, vaccines against common veterinary coronaviruses are routinely used to prevent serious diseases in young animals, such as a vaccine given to pigs to prevent serious enteric coronavirus disease. These models could prove useful as we develop vaccines to protect humans.

To further accelerate SARS vaccine research and development efforts, NIAID is initiating contracts with companies, institutions and other organizations who have relevant technologies, cell lines and containment facilities; supporting the development of reagents needed for vaccine development; and developing animal models such as mice and relevant species of monkeys.

Therapeutics Research.

As the nation began its focus on SARS, NIAID responded rapidly to a request from CDC to evaluate candidate antiviral therapeutic agents through a collaborative antiviral drug-screening project at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID). NIAID also has initiated discussions with the pharmaceutical industry about candidate antiviral drugs, and is reviewing a proposal for a clinical trial of antiviral therapy to be conducted by investigators of the NIAID Collaborative Antiviral Study Group and the NIH Clinical Center.

Clinical Research.

Clinicians treating SARS patients have not yet identified treatment strategies that consistently improve prognosis, beyond good intensive and supportive care. Antibiotics do not work, a fact that is consistent with SARS being a viral disease. However, some improvement has been noted in certain patients treated with a combination of ribavirin and corticosteroids, which are given together in an effort to simultaneously block viral replication and modify the immune system reaction to the virus.

At the NIH Clinical Center in Bethesda, MD, and through the NIAID Collaborative Antiviral Study Group, NIH is preparing to admit SARS patients for evaluation and treatment, should this become necessary. This will be an opportunity to evaluate the efficacy of antiviral and immune-based therapies, including interferons, in patients with SARS. We also plan to evaluate approaches to improve management of patients with severe forms of the disease, including the passive transfer of antibodies from SARS patients who have recovered from the disease.

In addition to ensuring state-of-the-art treatment of potential patients, our clinical experts will be able to study the clinical characteristics of patients with SARS. We are particularly interested in answering key questions about the disease mechanisms of SARS. For example, are acute respiratory distress and mortality entirely caused by the presence of virus, or could it be that the response of the immune system is causing the severe outcomes in some patients?

This is a central question to address because it may open up an avenue for treatment in addition to antiviral drugs.

Basic Research.

NIAID currently is supporting 18 grants on coronavirus research. Also, the study of patients, as well as specimens in NIAID laboratories, will facilitate studies of the natural history of the SARS agent and its potential animal reservoir, and help to illuminate the risk factors and epidemiology of SARS. NIAID will support and conduct basic research studies on the pathogenesis of the disease and viral replication mechanisms, in order to identify targets for antiviral drugs, diagnostic tests and vaccines. Finally, the Institute will support and conduct genomic sequencing, proteomics and informatics of coronaviruses.

Of note, an existing NIAID animal model of a virus infection that causes a disease in mice very similar to SARS has been identified. The relevance of this animal model will be evaluated and may prove an important tool for defining treatment approaches to SARS that involve modulation of the immune system.

Infrastructure.

A central concern when working with the SARS virus or SARS patients is the availability of facilities with the required safety level for the clinicians and staff, as well as for the community. Our ongoing plans to develop high-level containment facilities will facilitate SARS research, as well as planned studies of potential bioterror agents and other emerging diseases.

CONCLUSION

Mr. Chairman, thank you again for allowing me to discuss our efforts to address SARS. Despite ongoing research efforts and early successes, we still have much to learn about the disease. As you have heard, NIAID-sponsored coronavirus research, studies of other viral diseases, and clinical research already have provided results that are relevant to our quest for tools to detect, treat and prevent SARS. In the weeks and months ahead, NIH will continue to collaborate with our sister agencies the CDC and the Food and Drug Administration, as well as other relevant agencies to accelerate and expand our research aimed at improving the diagnosis, prevention, and treatment of SARS.

I would be pleased to answer your questions.

PREPARED STATEMENT BY DAVID L. HEYMANN, M.D.

At this moment, public health authorities, physicians and scientists around the world are struggling to cope with a severe and rapidly spreading new disease in humans, severe acute respiratory syndrome, or SARS. This appears to be the first severe and easily transmissible new disease to emerge in the 21st century. Though much about the disease remains poorly understood, including the exact identity of the causative virus, we do know that it has features that allow it to spread rapidly along international air travel routes.

As of 7 April, 2601 SARS cases, with 98 deaths, have been reported to WHO from 18 countries on four continents. Some outbreaks have reassuring features. A high awareness of SARS symptoms among travellers and the medical and nursing professions has often resulted in good management of imported cases—prompt isolation of patients and management according to strict procedures of infection control. As a result, many countries having only a single or a few imported cases have experienced no further spread to hospital staff, families of patients and hospital visitors, or the community at large. However, other outbreaks, most notably in Toronto, Hong Kong, Hanoi, and Singapore, give rise to considerable concern.

One of the most alarming features of SARS is its rapid spread in hospitals, where it has affected a large number of previously healthy health care workers. Many require intensive care, placing a huge strain on hospital facilities and staff. In Toronto, SARS is continuing to spread despite the introduction of strict patient isolation and excellent infection control. To date, Canada has reported 90 probable cases and 9 deaths. All cases have occurred in persons who have travelled to Asia or had close contact with SARS cases in households or health care facilities. Several Canadian schools and at least two hospitals are closed.

Hong Kong, with 883 cases and 23 deaths, is presently the hardest hit area. Health care workers continue to become infected in a growing number of hospitals. WHO learned today that the chief executive of the Prince of Wales Hospital—the initial epicentre of the Hong Kong outbreak—is hospitalized with atypical pneumonia. Hospitals are overwhelmed. A decision to suspend all primary, secondary, special schools and kindergartens until 6 April has been extended up to 21 April. Most disturbing is a large cluster of 268 SARS cases linked to the Amoy Gardens estate of high-rise apartment buildings. The vast majority of Amoy Gardens cases have been traced to vertically linked apartments in a single building, Block E. This pattern of transmission indicates that the disease has moved out of the health care setting and is now occurring within the community as secondary cases. Epidemiologists investigating the Amoy Gardens outbreak are considering the hypothesis that some form of environmental contamination, perhaps linked to a sewage system, is the source of the large cluster of cases. Although transmission through the faecal-oral route is being considered as one possibility, no evidence of airborne transmission has been demonstrated to date.

In Viet Nam, an epidemiologist from the Hanoi WHO office recognized the first case of SARS on 28 February at a French hospital in Hanoi. The number of cases increased rapidly but then stabilized on 24 March at 58 cases and remained stable for 10 consecutive days. As the maximum incubation period for SARS is thought to be 10 days, the stable number of cases over this period raised hope that Viet Nam's outbreak had been brought under control. However, on 3 April a probable SARS case was detected in a provincial hospital. Though the case could be linked back to the French hospital, the absence of isolation and rigorous infection control at the provincial hospital suggests that many hospital staff, patients, and visitors may have been exposed, thus possibly seeding further waves of cases. An additional two probable cases in the province were reported today.

In Singapore, another of the earliest and hardest hit areas, 106 persons, including 3 children under the age of 18 years, have been diagnosed with SARS. Most disturbing is a new cluster of 29 suspected SARS cases among health workers in two inter-linked wards at Singapore General Hospital. Epidemiologists investigating the outbreak are considering whether some environmental source, as suspected in the Amoy Gardens outbreak, might account for the unusual clustering of cases.

Through new mechanisms set up by WHO, progress on the research front has been unprecedented, particularly in the rapid discovery of a new coronavirus and the rapid development of diagnostic tests. The best scientists from around the world are working on these problems around the clock, and in an unprecedented spirit of collaboration against a threat of, as yet, unknown dimensions. Nonetheless, we still do not have conclusive proof that the new virus is indeed the cause of SARS. The results of animal experiments, which are currently being conducted by a laboratory in a WHO network, will be available soon and may provide the last pieces of evidence needed for definitive proof that SARS is caused by the newly discovered coronavirus. Furthermore, the findings will provide additional evidence to understand the role of metapneumovirus as a possible "helper virus" in persons co-infected with the new coronavirus. The development of a diagnostic test has also proved more problematic than hoped. Three diagnostic tests are now available, but all have limitations as tools for getting this outbreak quickly under control. The ELISA detects antibodies reliably but only from about day 20 after the onset of clinical symptoms. It therefore cannot be used to detect cases at an early stage before they have a chance to spread the infection to others. The second test, an immunofluorescence assay (IFA), detects antibodies reliably as of day 10 of infection, but is a demanding and comparatively slow test that requires the growth of virus in cell culture. The presently available PCR molecular test for detection of SARS virus genetic material is useful in the early stages of infection but produces many false negatives, meaning that many persons who actually carry the virus may not be detected—creating a dangerous sense of false security for a virus that is known to spread easily in close person-to-person contact.

Against this background about the dimensions of the SARS outbreak, the sections below explain why this disease poses a particularly severe threat to international health, outline the chronology of events as SARS spread around the world, and discuss lessons, based on strengths and weaknesses of the global response, for the immediate future. These lessons are of great importance. The SARS response is the roll out of a global alert and response activity under the revision of the International Health Regulations, which provide the legal framework for the surveillance and reporting of infectious disease and for the use of measures to prevent their international spread. This roll out is showing how the alert and response activity works in practice for a newly identified disease. It also indicates how the system now in operation could apply to other highly significant infectious disease events,

including the next influenza pandemic, the next emerging infection, and the deliberate release of a biological agent in an act of warfare or terrorism. The scientific community is now contending with an outbreak caused by a new virus. This creates an extra step in the containment response: identification and characterization of the causative agent, which then allows development of a diagnostic test, treatment protocols, and a scientifically sound basis for recommending control measures. This is a step that would not be needed should a biological attack occur using a well-known pathogen such as anthrax or smallpox. The response to an influenza pandemic would likewise not be dealing with an entirely new and poorly understood virus.

SARS: a particularly serious threat to international health

Although the last decades of the previous century witnessed the emergence of several new diseases, SARS needs to be regarded as a particularly serious threat for several reasons. If the SARS virus maintains its present pathogenicity and transmissibility, SARS could become the first severe new disease of the 21st century with global epidemic potential. As such, its clinical and epidemiological features, though poorly understood, give cause for particular alarm. With the notable exception of AIDS, most new diseases that emerged during the last two decades of the previous century or established endemicity in new geographical areas have features that limit their capacity to pose a major threat to international public health. Many (avian influenza, Nipah virus, Hendra virus, Haanta virus) failed to establish efficient human-to-human transmission. Others (Escherichia coli O157:H7, variant Creutzfeldt-Jakob disease) depend on food as a vehicle of transmission. Diseases such as West Nile Fever and Rift Valley Fever that have spread to new geographical areas require a vector as part of the transmission cycle and are associated with low mortality, often in high-risk groups, such as the elderly, the immunocompromised, or persons with co-morbidity. Still others (*Neisseria meningitidis* W 135, and the Ebola, Marburg, and Crimean-Congo haemorrhagic fevers) have strong geographical foci. Although outbreaks of Ebola haemorrhagic fever have been associated with case-fatality rates in the range of 53% (Uganda) to 88% (Democratic Republic of the Congo), person-to-person transmission requires close physical exposure to infected blood and other bodily fluids. Moreover, patients suffering from this disease during the period of high infectivity are visibly very ill and too unwell to travel.

In contrast, SARS is emerging in ways that suggest great potential for rapid international spread under the favourable conditions created by a highly mobile, closely interconnected world. Anecdotal data indicate an incubation period of 2 to 10 days (average 2 to 7 days), allowing the infectious agent to be transported, unsuspected and undetected, in a symptomless air traveller from one city in the world to any other city having an international airport. Person-to-person transmission through close contact with respiratory secretions has been demonstrated. The initial symptoms are non-specific and common. The concentration of cases in previously healthy hospital staff and the proportion of patients requiring intensive care are particularly alarming. This "21st century" disease could have other consequences as well. Should SARS continue to spread, the economic consequences—already estimated at around US \$6 billion in business losses in the initial weeks—could be great in a closely interconnected and interdependent world.

Chronology of events leading to an unprecedented emergency travel advisory.

Severe Acute Pulmonary Syndrome (SARS) was first identified in Viet Nam on 28 February, 2003, when Dr. Carlo Urbani, an epidemiologist from the Hanoi WHO office examined a patient with a severe form of pneumonia for which no etiology could be found. Two days later, on 10 March 2003 at least 22 hospital workers in Hanoi French Hospital were ill with a similar acute respiratory syndrome, and by 11 March similar outbreaks had been reported among hospital workers in Hong Kong.

SARS occurred at a time of heightened surveillance for atypical respiratory disease. From 10 February the WHO office in Beijing, which reinforced its staff with two epidemiologists, had been working with the government of China to learn more about an outbreak of atypical respiratory disease that affected health workers, their families and contacts in Guangdong Province, with 305 cases and 5 deaths reported from 16 November 2002 to 7 February 2003. Around 30% of cases were reported to occur in health care workers. Surveillance was heightened further when a 33-year-old man who had travelled with his family to Fujian Province in China died in Hong Kong on 17 February. The next day, Hong Kong authorities announced that avian influenza A(H5N1) virus, the cause of "bird flu", had been isolated from both the man and his nine-year-old hospitalized son. Another member of the family, an eight-year-old daughter, died while in Fujian and was buried there.

On 12 March, after an assessment of the situation in Asia with WHO teams in Hanoi, Hong Kong and Beijing, a global alert was issued about cases of severe atypical pneumonia with unknown etiology that appeared to place health workers at high risk.

Two days later, on 14 March, WHO received a report from the government of Canada that health authorities had taken steps to alert hospital workers, ambulance services, and public health units across the provinces that there were four cases of atypical pneumonia within a single family in Toronto that had resulted in 2 deaths. At 02h00 Geneva time on the following day, 15 March, the government of Singapore notified WHO, by urgent telecommunication, of a similar illness in a 32-year-old physician who had treated hospital workers with a severe respiratory syndrome in Singapore, including one from the French Hanoi hospital who had self-evacuated to Singapore. This Singapore physician had travelled to the United States for a medical conference, and at the end of the conference boarded a return flight to Singapore in New York. Before departure he had indicated to a colleague in Singapore by telephone that he had symptoms similar to the patients he had treated in Singapore. The colleague notified health authorities. WHO identified the airline and flight, and the physician and his accompanying family members were removed from the flight at a stopover in Frankfurt, Germany, where he was immediately isolated and placed under hospital care, as were his two accompanying family members when they developed fever and respiratory symptoms several days later. As a result of this prompt action, Germany experienced no further spread linked to the three imported cases.

Later in the morning of 15 March, with this background and chronology of events, a decision was made by WHO to increase the level of the global alert issued on 12 March. The decision was based on five different but related factors. First, the etiology, and therefore the potential for continued spread, of this new disease were not yet known. Second, the outbreaks appeared to pose a great risk to health workers who managed patients, and to the family members and other close contacts of patients. Third, many different antibiotics and antivirals had been tried empirically and did not seem to have an effect. Fourth, though the numbers were initially small, a significant percentage of patients (25 of 26 hospital staff in Hanoi, and 24 of 39 hospital staff in Hong Kong) had rapidly progressed to respiratory failure, requiring intensive care and causing some deaths in previously healthy persons. Finally, the disease had moved out of its initial focus in Asia and appeared to have spread to North America and Europe.

At this time, the epidemiology of SARS was poorly understood. A virulent strain of influenza had not been ruled out as a possible cause, even though transmission patterns were not characteristic for influenza. There was also some hope that the new disease, like many other new diseases of the recent past, would fail to maintain efficient person-to-person transmission, or that it might attenuate with passage and eventually self-contain. Despite the lack of understanding about the disease, its cause, and future evolution, the need was great to introduce a series of emergency measures to contain SARS outbreaks in the affected areas and prevent further international spread, thus reducing opportunities for the new disease to establish endemicity. WHO thus decided, on 15 March, to issue a rare emergency travel advisory as a global alert to international travellers, health care professionals, and health authorities.

The global alert called for increased attention to patients with atypical pneumonia who fit the following case definition:

High fever ($>38^{\circ}\text{C}$)

One or more respiratory symptoms including cough, shortness of breath, difficulty breathing
AND

One or more of the following:

Close contact with a person who has been diagnosed with SARS

Recent history of travel to areas reporting cases of SARS.

At the same time the global alert recommended no change in patterns of international travel, but that passengers notify their health authority if they should develop signs and symptoms as described above and have a history of travel to areas reporting cases of SARS. Following this alert, awareness increased immediately, and many potential new outbreaks were prevented by the prompt isolation and strict management of suspected cases.

By 27 March, however, it was evident that international spread of SARS had continued after the 15 March advisory at two of the earliest outbreak sites, namely Viet Nam and Hong Kong, and that persons on the same aeroplanes as persons with symptoms consistent with SARS, and sitting in close proximity to them, had developed signs and symptoms compatible with SARS. On this date it was decided to rec-

ommend new measures related to international travel, still with the intent of preventing the international spread of the infectious agent. These recommendations were that SARS-affected areas, where transmission was known to be occurring in chains of human-to-human transmission, institute measures to identify international passengers who had signs, symptoms and history compatible with SARS, and to recommend that such persons postpone international travel and seek medical advice. These recommendations were instituted in most of the affected areas shortly after 27 March.

However, concern continued to mount. An urgent investigation of the Amoy Gardens outbreak in Hong Kong began on 29 March, and the following day, health officials announced that 213 Amoy residents were probable cases of SARS. This followed an unusual cluster of cases, closely linked in time and place, among guests and visitors who had stayed on the same floor of a hotel located in the same district (Kowloon) as Amoy Gardens. By this same date, 9 business travellers and tourists had returned to Singapore, Beijing and Taiwan from Hong Kong, either sick or in the incubation period of SARS.

Outbreaks in the hotel and housing estate indicated that SARS was showing an unusual pattern of transmission in Hong Kong, probably involving an environmental component, that would place persons at risk outside the confined health care settings associated with outbreaks in most other countries. The 9 cases of probable SARS that occurred in Singapore, Beijing, and Taiwan, and that were associated with travel in Hong Kong, indicated that the risk of international spread was continuing. Consultations were made with WHO teams and travel experts. On 2 April a recommendation for voluntary postponement of all but essential travel was issued for travellers considering travel to Hong Kong. At the same time, because the WHO team and government of China had confirmed that the 4-month long outbreak in Guangdong continued, and that cases fit the case definition being applied in Viet Nam and Hong Kong, and because transmission patterns in Guangdong were not yet available, these same recommendations were made for Guangdong as maximum security against spread of SARS outside of Guangdong in the absence of complete understanding of transmission patterns of the outbreak there.

Cases of possible transmission in aeroplanes continue to be reported and investigated. As recently as 5 April, notification of a SARS patient travelling internationally by sea from Hong Kong to Vladivostok (Russian Federation) was received, opening a possible second route of international travel for the virus.

WHO travel recommendations are kept under constant review and will be amended as more data about the evolution of SARS become available.

Lessons: the value of innovation and international collaboration

The knowledge obtained in the three-week period since 15 March has been remarkable. It demonstrates the value of international cooperation on emerging infections and the importance of early detection and rapid introduction of emergency measures to prevent further international spread and help ensure that imported cases are not allowed to cause disease in others.

When WHO began to set up emergency plans on 15 March, identification of the SARS causative agent and the development of a diagnostic test were given paramount importance in the overall containment strategy. Detection of the disease in its early stage, confirmation of cases, understanding modes of transmission, development of protocols for targeted treatment, vaccine research and development, and implementation of disease-specific preventive measures would all depend upon swift progress and results in etiological and diagnostic research. Sound public health measures would also require understanding of the presence and concentration of the pathogen in different tissues and secretions, and patterns of excretion throughout the course of illness and convalescence. So long as the aetiological agent remained unknown, specialists in infectious disease control would be forced to resort to control tools dating back to the "Middle Ages" of microbiology: isolation and quarantine.

On 17 March, a network of 11 leading laboratories around the world was set up as a mechanism for expediting identification of the SARS causative agent. Laboratories were selected on the basis of three criteria: outstanding scientific expertise, facilities at biosafety level III, and capacity to contribute to the battery of tests and experiments that would be needed to fulfill Koch's four postulates for the identification of an infectious agent as the cause of a specific disease. The network was set up on the model of the influenza network and provides another important lesson: models and systems set up for one health emergency can be rapidly adapted to serve others.

Collaboration is virtual. Members of the network confer in daily teleconferences coordinated by WHO, and use a secure web site to post electron microscopic pictures of candidate viruses, sequences of genetic material for virus identification and char-

acterization, descriptions of experiments, and results. The well-guarded secret techniques that give each laboratory its competitive edge have been immediately and openly shared with others. Laboratories also quickly exchange various samples from patients and postmortem tissues. These arrangements have allowed the analysis of samples from the same patient simultaneously in several laboratories specialized in different approaches, with the results shared in real time. This collaboration has resulted in the identification of the suspected causative agent, and the development of three diagnostic tests, with unprecedented speed.

Virus isolation continues from patients with SARS, and at the same time virus has been isolated from tears and faeces. Publications on these various findings are being prepared by members of this collaborating group, but the need remains for a highly sensitive and specific PCR test to diagnose acute infections. Although 20% of the virus has been sequenced, continued around-the-clock collaboration is taking place to rapidly complete sequencing.

A similar collaborative group on epidemiology, made up of investigators from all sites with local transmission of SARS, continues to confirm person-to-person transmission as the major route of transmission. Today, the group exchanged information about the Hong Kong investigations to identify a possible environmental source, which might prove useful in understanding the unusual new cluster of cases in Singapore. Key questions include the exact points during the course of incubation and infection when transmission occurs and whether asymptomatic cases are also capable of spreading SARS. These questions must be answered to better evaluate the extent of spread of SARS, and the success of containment activities.

A third clinical group, which unites 80 clinicians from 13 countries having SARS cases, has consistently provided anecdotal information about the lack of efficacy of treatment with specific antibiotics and antivirals, and has begun to develop systematic clinical trials of Ribavirin at two sites. Their discussions have shed light on features of the disease at presentation, treatment and progression of the disease, prognostic indicators, and discharge criteria. No therapy has been shown to demonstrate any particular effectiveness. The clinicians agreed that a subset of SARS patients, perhaps 10%, decline, usually around day 7, and need mechanical assistance to breathe. The care of these people is often complicated by the presence of other diseases. In this group, mortality is high. Age over 40 years also appears to be associated with a more severe form of disease.

Countries have made travel recommendations for their citizens, using the guidance provided by WHO and other considerations such as feasibility of medical evacuation of their citizens and their insurance coverage should they become infected.

On 28 March, at the end of the second week of the global response, China, a reluctant partner in the global alert and response at the start, became a full partner in the three working groups that were studying SARS, and concluded that the outbreaks of SARS elsewhere in Asia were related to the outbreak in Guangdong Province. The Chinese government has announced that SARS is being given top priority. A system of alert and response for all emerging and epidemic-prone diseases is being developed. Daily electronic reporting of new cases and deaths, by province, has begun. Equally important, health officials have begun daily televised press conferences, thus taking the important step of increasing the awareness of the population and hospital staff of the characteristic symptoms, the need to seek prompt medical attention, and the need to manage patients according to the principles of isolation and strict infection control.

The next weeks and months will tell whether the global alert and response will contain the current SARS outbreaks, preventing SARS from becoming yet another endemic infectious disease in human populations, or whether SARS will remain confined to its origins in nature, to re-emerge at yet another time and place. It is clear that the responsibility for containing the emergence of any new infectious disease showing international spread lies on all countries. In a world where all national borders are porous when confronted by a microbial threat, it is in the interest of all populations for countries to share the information they may have as soon as it is available. In so doing, they will allow both near and distant countries—all neighbours in our globalized world—to benefit from the understanding they have gained.

[Whereupon, at 1:43 p.m., the committee was adjourned.]

